THE Petroleum Engineer

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A MAGAZINE OF METHODS FOR OPERATING MEN

This Issue Contains

Page

DRILLING AND PRODUCTION

Casing Pumps in Winkler Field - - - - - - - - - - - - - - - 29
By J. C. Albright
High-Pressure Manifold on Gas Well - - - - - - - - - - - - 31
Controlled Directional Well-Drilling and Surveying Practice (Part 5) - 32
By Jas. D. Hughes
Metering Production From Individual Wells - - - - - - - - - 36
By Wallace A. Sawdon
Operation of Two-Speed Variable Speed Motor Without Controller - 50
By W. C. Lane
Redrilling and Cleaning-Out Operations in Shallow "Shoestring" Pools—Eastern Kansas - - - - - - - - - - - - - - - - 84
By Frank B. Taylor
Elements of Applied Petroleum Production (Article 26) - - - - - - 88
By K. C. Sclater

REFINING AND NATURAL GASOLINE MANUFACTURE

First High-Pressure Gas-Rectifying Plant in Oklahoma Converted into Combination Gas-Rectifying and Absorption Plant - - - - - - - 27
By Frank H. Love
New Refinery at Hamburg, Germany, Running on East Texas and Mid-Continent Crudes - - - - - - - - - - - - - - - - - - 46
Acid Treating Lubricating Oils to Improve Viscosity Index - - - - - 56
By George M. Woods
Liquid-to-Liquid Heat Exchangers - - - - - - - - - - - - - - - 59
By R. H. Turner
Elements of Applied Petroleum Refining (Article 26) - - - - - - - 94
By W. L. Nelson

OIL AND GAS TRANSPORTATION

Improving Operation of Diesel Engine - - - - - - - - - - - - 53
By Elton Sterrett
Elements of Applied Petroleum Pipe Line Transportation (Article 17) - 90
By C. E. Main, Sr.
Reconditioning and Relaying Three Approaches at Trunk Pipe-Line River Crossing - 110
By Frank H. Love

GENERAL

How Many Gallons in Any Vertical Cylindrical Tank? - - - - - - - 35
By W. F. Schaphorst
Fundamentals of the Internal Combustion Engine (Part 1) - - - - - 41
By Joseph Liston

REGULAR DEPARTMENTS

The Course of Oil - 17
Highlights in Oildom - - - - - - - - - - - - - - - - - - - 18
Progress of Major Pipe Line Work - - - - - - - - - - - - - - 20
Latest Activities in the Oil Fields - - - - - - - - - - - - - 22 and 23
The Month's Activities in Refining - - - - - - - - - - - - - - 24
New Petroleum Equipment - - - - - - - - 66, 67, 68, 70, 71, and 72
Pictorial Petroleum - 75
Laugh With Barney - 100
Running Tour With Men in the Industry - - - - - - - - - - - 102

Meetings

California Natural Gasoline Association—January 2, Richfield Building, Los Angeles.

Mid-Continent District Petroleum Division of A.P.I., Spring Meeting—February 20 and 21, Wichita, Kansas.

American Society for Testing Materials, Regional Meeting—March 4, William Penn Hotel, Pittsburgh, Pennsylvania.

American Association of Petroleum Geologists, 21st. Annual Meeting—March 19, 20, and 21, Tulsa, Oklahoma.

Petroleum Industry Electrical Association—April 11, 12, and 13, Tulsa, Oklahoma.

American Chemical Society, Petroleum Division, Symposium on Motor Fuels—April 13-17, Kansas City, Mo.

Oil Equipment and Engineering Exposition—April 20, 21, 22, 23, 24, and 25, Houston, Texas.

Natural Gasoline Association of America, Annual Meeting—May 13, 14, and 15, Mayo Hotel, Tulsa, Oklahoma.

International Petroleum Exposition—May 16-23, Tulsa, Oklahoma.

Pennsylvania Crude Oil Association, Annual Meeting—June 18 and 19, State College, Pennsylvania.

American Society for Testing Materials, Annual Meeting—June 29 to July 3, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

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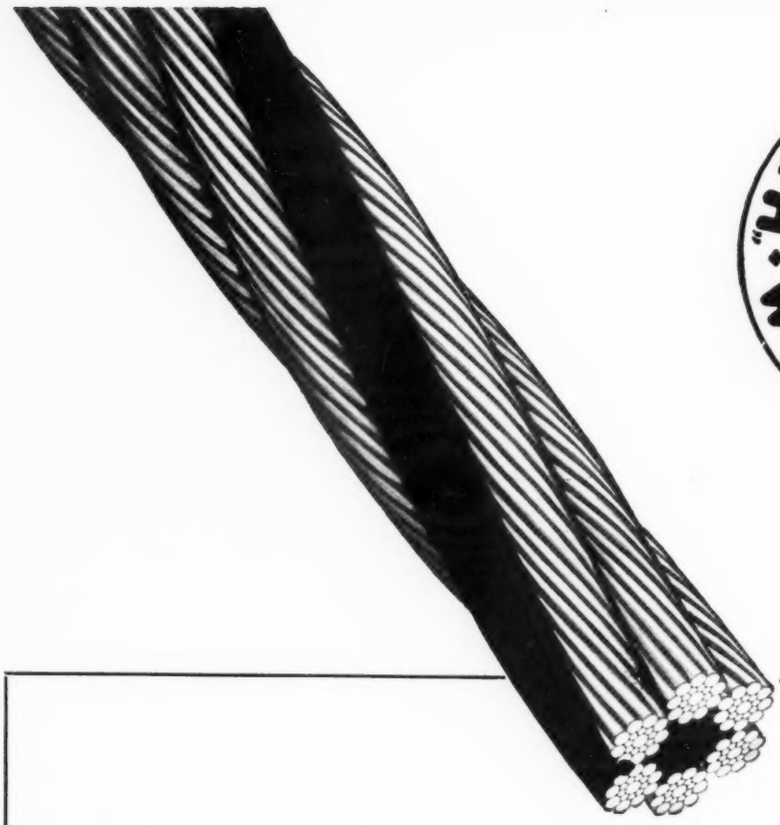

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The Course of Oil

By K. C. SCLATER

Gasoline Yield Increased

Polymerization of normally gaseous hydrocarbons had an important place on the program of the Refining Division of the A.P.I. meeting in Los Angeles last month. In a paper on the thermal process for polymerization of olefin-bearing gases it was pointed out that our gasoline production could be increased some ten to twenty-five percent (of our total consumption) from the same amount of crude oil per day. Such an increase is in reality an added refinery operating economy, as in the process described, vapor-phase cracking-still gases can be converted into gasoline. Natural-gasoline tops and natural gas can also be used.

The commercial application of this process for the conversion of refinery residue gases in this manner is the result of the refining industry's intensive research in answer to an increasing demand for anti-knock fuel. High compression super-charged aviation motors of today demand fuel with octane ratings far beyond anything considered heretofore.

This development is a true conservation measure in that the yield of gasoline per barrel of crude oil is substantially increased. The fact that the refinery gases polymerized to make gasoline have heretofore virtually been considered a waste product adds to the value of the process. It marks an important step in refining progress.

Mutual Engineering Problems

A reflection of the increasing interest among petroleum engineers and production men in the materials that go into the manufacture of oilfield equipment was quite evident at the A.P.I. group sessions in Los Angeles last month. At the meetings of the Division of Production several papers were read on steel, alloy steel, and iron. The papers dealt chiefly with the fundamental characteristics of these metals; their fatigue and corrosion was also discussed. As was stated on the program, "these papers are for the purpose of providing a better understanding by engineers, purchasing agents, and field men regarding the various chemical and physical properties of materials used in oilfield equipment."

Fatigue and corrosion are two items that affect the service life of equipment and therefore enter largely into production and refining costs. There is also the strength of the materials of which the equipment is made to be considered; this assumes at least a working knowledge of metallurgy.

Authoritative papers on these and related subjects are therefore needed and much to be desired. A forum for discussion of their mutual problems by the metallurgical engineer and the petroleum engineer on a basis such as is provided at these A.P.I. group sessions may fill this need.

Futile Well-Spacing Comparisons

There are many angles to the well-spacing problem. Its intricacy is appreciated by those who have given it study. The various important factors that enter and their relative significance are, however, sometimes only vaguely understood. Such miscomprehension often leads to fatuous comparisons of well-spacing between fields.

One such comparison was recently made between the East Texas field and the Santa Fe Springs and Signal Hill fields, California. It was inferred from remarks made regarding the well-spacing in these fields that, the well-spacing in the East Texas field compared more than favorably (not too dense) with Signal Hill and Santa Fe Springs fields so far as the number of wells per acre was concerned—the number of wells per acre, this seemed to be as far as the reasoning went. No thought was given to subsurface conditions such as the thickness and saturation of the producing sands, two of the most important considerations entering into the determination of the proper well-spacing.

Producing sands in Signal Hill and Santa Fe Springs fields are hundreds of feet thick and have a comparatively steep dip. In the East Texas field the average thickness of the producing sand is less than 100 ft. and has a comparatively slight dip. One would, therefore, expect recovery per acre in Signal Hill and Santa Fe Springs fields to be many times higher than in East Texas. It is easy to understand that the greater the normal thickness of the producing sand and the steeper the dip the greater will be the acre recovery and the closer can wells be spaced. As obvious as these conditions pertaining to well-spacing are, it would seem that they are frequently overlooked. Another condition that would make it appear that the wells in the Santa Fe Springs field are closer spaced than they really are is that there are several distinct producing horizons that are not all produced through one well.

There is also the issue concerning recovery that is being argued with respect to the East Texas field. This is, that the more wells drilled the greater will be the ultimate recovery.

Certainly under similar methods of production the greatest number of wells should result in the greatest ultimate recovery. But the real issue is not a question of the greatest ultimate recovery but the greatest economic recovery; that is, the greatest recovery at the minimum cost. It is only clouding the issue by arguing about something that is almost a palpable fact. Ultimate recovery and economic recovery are not one and the same thing. The assumption that they are leads to the utmost confusion—but perhaps this is the means taken to confute the issue, if such there really be.

« « « HIGHLIGHTS IN OILDOM » » »

Stronger Crude Market In California and Pennsylvania

Recent advances in prices have greatly strengthened the crude situation in California and Pennsylvania.

The price structure in California, which underwent such a drastic reduction in August, was virtually restored when the Standard Oil Company of California announced, effective December 6, increases up to 21 cents a bbl., depending upon gravity. The new listings showed Kettleman Hills 33-gravity crude advancing 12 cents to 91 cents, with 39-gravity up 21 cents to $1.11; Mountain View 34-gravity was boosted 14 cents to 91 cents; Huntington Beach 30-gravity was raised 13 cents to 95 cents; and Long Beach 27-gravity was up ten cents to 90 cents.

The recent advance of Pennsylvania Grade crudes places Bradford at $2.30 a bbl., Southwest at $2.02, Eureka at $1.97, Buckeye at $1.82, and Corning at $1.32.

●

Suits Threatened Against California Gas Wasters

George D. Nordenholt, director of natural resources for the State of California, has issued a warning to all oil producers in the state, informing them that injunctions are to be obtained against those thought to be guilty of unreasonable wastage of natural gas. The injunctions, he says, will be obtained under the provisions of the Gas Conservation Act, the only state law permitting legal action. Playa del Rey operators are faced by such an injunction, and certain operators at Mountain View already have had court proceedings instituted against them, while some producers in the Kettleman Hills field have been threatened.

●

Rehearing Denied in Well Spacing Case

In handing down a decision denying a rehearing in the case of C. H. Brown vs. Humble Oil and Refining Company, the Texas Supreme Court has reiterated its opinion expressed last summer that Rule 37, that portion of the oil and gas regulatory provisions governing well spacing, is valid. The original suit was filed to set aside an order of the Railroad Commission granting Brown a permit to drill a well on a one and one-half-acre tract in the East Texas field, the permit being granted as an exception to the established spacing rules of the field. The Supreme Court upheld the Railroad Commission's order.

In making its recent decision, the Supreme Court clearly pointed out that it had not intended in its original opinion to hold that proration orders of the commission must be based on acreage. Many holders of large acreage had so interpreted the decision.

To Gauge Oklahoma Pools By Decline Rule

The State Corporation Commission of Oklahoma has prescribed the methods that shall be used for determining new potentials for wells and leases of Class B pools in the state for the six-months period beginning January 1, 1936.

For the Allen, Asher-Wanette, Earlsboro, East Little River, Konawa, Little River, Maud, Mission, Sasakwa, Searight, and East Seminole pools a decline of one percent a month or a calendar month production test is prescribed.

A decline of three percent a month, with the option of 48-hour tests or seven-day tests for wells making 50 percent or more salt water, is prescribed for St. Louis, including Pearson, Sasakwa Townsite, and the pools of Seminole proper.

Calendar month production tests during January are prescribed for leases in the Oklahoma City (Simpson below Wilcox), Fish (Cromwell), and Tatums pools.

All leases in Class B pools having a potential capacity of 50 bbl. or less shall not be reduced, the commission has directed, and 48-hour gauges are prescribed for new wells completed after the new potentials period begins.

●

Increase in Drilling Activity

A total of approximately 21,000 wells will be drilled in the United States this year, according to the number completed to date and estimating the number yet to be drilled during the remainder of the month. Of this total 4,000 will be in the East Texas field, and the remaining 17,000 from all other sections of the country, representing an increase of 15 percent insofar as the country as a whole is concerned, exclusive of East Texas.

Drilling activity has been greater during 1935 than for any year since 1930 and will closely approach the figure of that year, which was 21,232 wells.

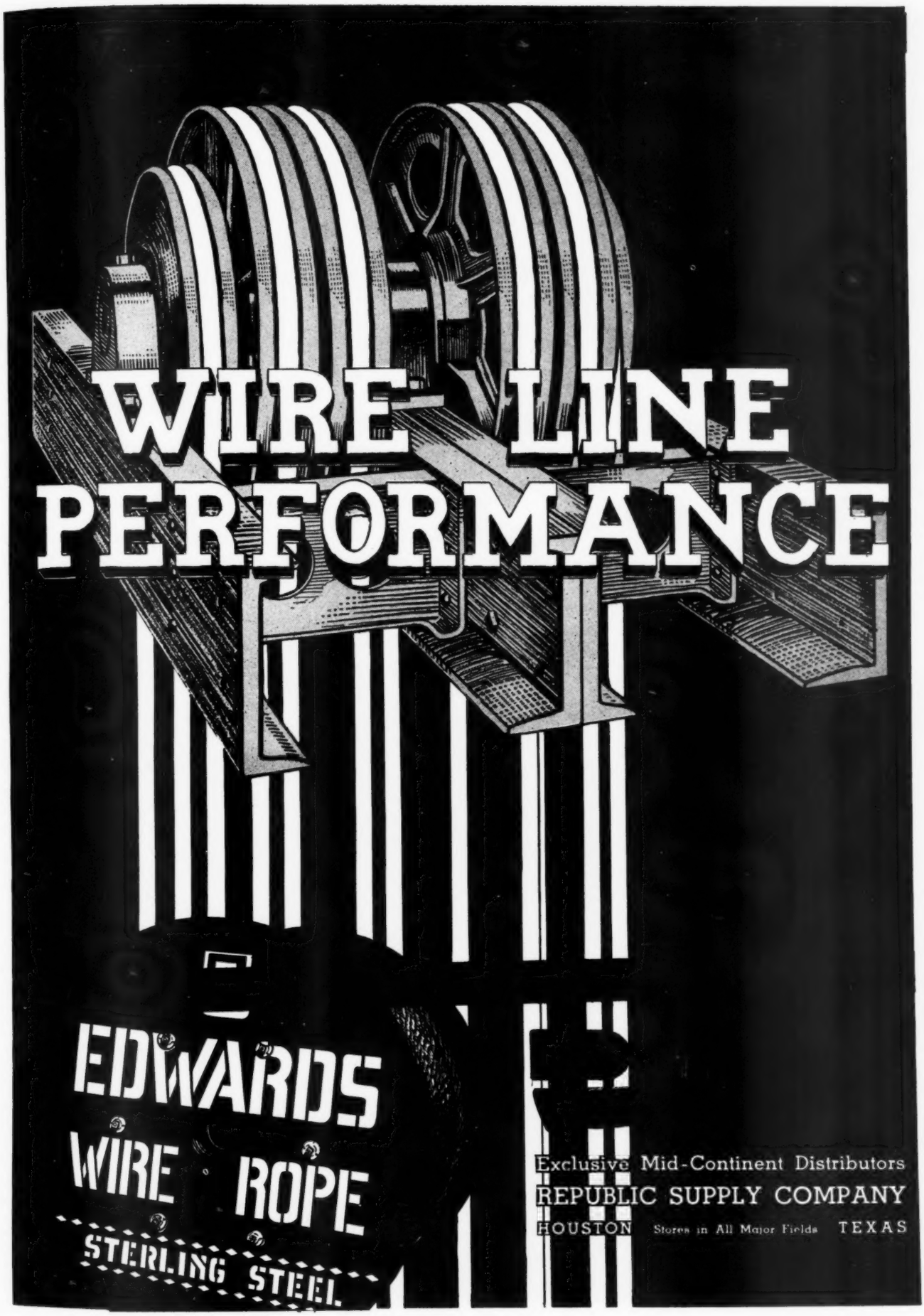
Operators are of the belief that the coming year will see a still further increase in drilling, basing their contention upon the fact that many leases are playing out in West Texas, New Mexico, Oklahoma, and Kansas, as well as upon the fact that operators will find it necessary to drill up their properties in order to maintain their share of the allowable.

●

Reservoir Pressure Up In East Texas

The most recent tests made by the East Texas Engineering Association reveal that weighted average reservoir pressure in the East Texas field registered a gain of one lb. compared with the previous survey. Readings taken on 310 key wells averaged 1195 pounds.

Bottom-hole pressure of the East Texas field has declined a total of 36 lb. since the first of the year, an average drop of 3.27 lb. per month. The greatest decline, amounting to seven lb., was shown in the tests made July 1.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PROGRESS OF MAJOR PIPE LINE WORK

CONSTRUCTION of a 6-in. pipe line from the Loma Novia field in Duval County, Texas, to Corpus Christi, a distance of approximately 90 miles, seems likely in the near future, negotiations now being under way. According to present plans it would have a capacity of 8000 bbl. daily and would tie into the General American Terminal and the Municipal docks at Corpus Christi. Among those interested in the project are Hamill & Smith of Houston, who have extensive holdings in the Loma Novia field; M. H. Reed and Ralph Ogden of Austin, and some of the former Yount-Lee officials of Beaumont. Although the contract has not been let, construction bids have been received.

Completion of the line will add approximately 8000 bbl. daily to the allowable of the Southwest Texas district. Pipe lines now serving Government Wells and adjacent fields are operating virtually to capacity.

●

The Continental Oil Company has announced it will lay a 6-in. pipe line to serve as an outlet for the Tepetate field of northwestern Acadia Parish, Coastal Louisiana. Details of the project have not been made known definitely, inasmuch as officials of the company have not determined whether the line will be laid directly to tidewater at Lake Charles, a distance of approximately 45 miles, or to a point below Jennings on the Mermentau River, where barges can be loaded. The company now has a temporary 4-in. line running to Bayou Nezpique, where loading docks are provided for barges.

●

The Stanolind Pipe Line Company has completed the laying of an 8-in. loop to its existing 6-in. line serving the Fitts pool of Pontotoc County, Oklahoma. The new line, 24 miles in length, extends from Byng to Coker Junction, after passing through the Maud station. From Coker Junction an 8-in. line leads to the trunk line of the company at Payson.

The construction of this line, and the addition of units at the Fitts and Maud stations, will increase the capacity of the system from 27,000 bbl. daily to 38,000 barrels. Prime movers at the Fitts station will be duplicated, being 300-hp. Cooper-Bessemer gas engines. Two 300-hp. engines will be installed at Maud. The prime movers at both stations will be direct-connected through gears to 3-stage centrifugal pumps of 350 lb. working pressure. They will be set in series, thus making possible a line pressure of 700 lb. if desired.

●

The Magnolia Pipe Line Company has announced plans to construct two additional main line pump stations on its 8-in. carrier between the Government wells district and Luling, Texas. By so doing the capacity of the line will be increased from 12,000 bbl. daily to 16,500 barrels. One station will be between the Duval and Fant stations. It will be equipped with reciprocating pumps driven by gas engines. The other station will be between Fant and Luling and will have centrifugal pumps driven by electric motors.

Work is under way on a 30-mile 4-in. gas line extending from the Sam Fordyce field to Mercedes, Texas. Those interested in the project are Showers & Moncrief, Inc., Murchison & Closuit, Inc., and Roy Moysten, all of Dallas. The firm organized by these interests for the purpose of constructing and operating the pipe line is known as the Hidalgo Gas Company and headquarters will be at McAllen.

No domestic users will be supplied, instead irrigation companies, canning plants, and other industries will be served.

The Fredell Construction Company is laying the line.

●

The Kansas Osage Gas Company, subsidiary of the Continental Oil Company, has awarded a contract to J. H. McCarthy, pipe line contractor of Tulsa, Oklahoma, for taking up approximately 16 miles of 10-in. 32-lb. coupled pipe line extending from Gray Horse to Burbank, Oklahoma. The pipe will be reconditioned, flame beveled, welded by the oxy-acetylene Lindeweld method, and relaid in the same ditch.

●

Th Continental Oil Company has indicated its intention of laying an 85-mile 8-in. welded oil line in Oklahoma, extending from Oklahoma City to the Jesse area in Pontotoc County.

A preliminary survey is being made of the route the line will take, and it will pass near, possibly through, the Fitts pool, providing an additional outlet for that field. Construction bids already have been asked.

The line would tie into the Continental's pipe line from the Oklahoma City field to its refinery at Ponca City.

●

The reconditioning project instigated last March by the Magnolia Pipe Line Company, calling for the working over of 500 miles of line in Texas, will soon be terminated for the winter months. It is expected that the work will be resumed in the spring. The line involved is an 8-in. carrier between Corsicana and Beaumont and Luling and Beaumont. This has represented the largest reconditioning program in the State of Texas during the past year.

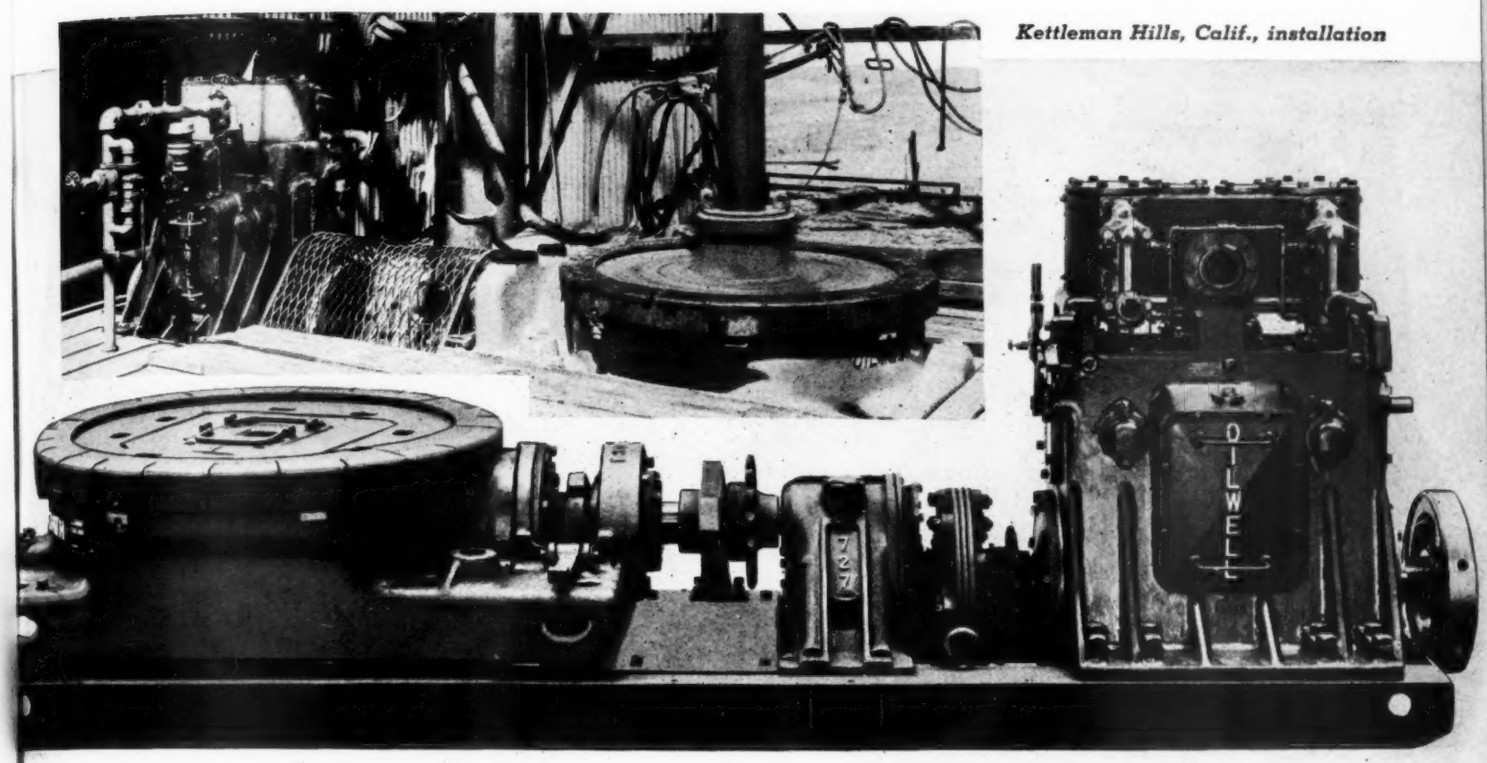
●

The Oklahoma Contracting Company of Dallas, Texas, has been awarded a contract by the Humble Pipe Line Company to lay an 8-mile gathering system in Rusk County, East Texas field. The pipe will be of varying size.

●

An 8-in. oil line has been completed from Tempino to Pladjoe in Sumatra, Netherlands India, by Nederlandsch-Indische Aardolie Maatschappij, owned jointly by the government of Netherlands India and de Bataafsche Petroleum Maatschappij (Royal Dutch Shell interest), thus reducing to 166 miles the distance it is necessary to pump the crude compared with 227 miles it had to be pumped in the old line, which the new carrier supplements.

A REVOLUTION IN ROTARY DRILLING



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LATEST ACTIVITIES IN THE OIL FIELDS

THE deep test of the Union Oil Company (No. 1 Lillis-Welsh) in the Kettleman North Dome field of California is being watched with much interest. It is considered the most important drilling operation under way in the state at the present time, as it will determine the deep zone possibilities of the North Dome field. A few hundred feet short of an 11,000-ft. depth, the test has shown a number of promising signs, and something definite is expected to develop before the end of the month.

●

In Belmont County, Southeast Ohio, a small producer has been completed by the Richland Syndicate that extends the Richland Township pool. It was drilled to a total depth of 1882 feet in the Berea sand and produced 18 bbl. naturally the first day.

●

A pool opener in Ector County, Texas, is York & Harper's No. 1 H. V. Foster, three miles northeast of the Addis pool. At a total depth of 4104 ft. the hole filled 2000 ft. with oil in 48 hours. Production is from lime formation.

●

Wakefield et al's No. 1 Hannah has been brought in as a discovery well in Cowley County, Kansas. Production is from the Bartlesville sand at a total depth of 2994 ft., and on the initial test the well made 157 bbl. of oil a day.

●

Another pool for Lea County, New Mexico, seems probable as a result of Skelly Oil Company obtaining a good showing of oil in its No. 1 Harrison. At a total depth of 3775 ft. there was 3000 ft. of oil in the hole. Subsequently the test was deepened to 3780 feet.

●

Successful completion of the Santa Clara Oil Company's No. 1 Driscoll Sevier in Nueces County, Texas, has opened a new coastal field, and resulted in one of the most active lease plays in Southwest Texas in recent months.

The well was drilled to a total depth of 3816 ft., penetrating the producing sand eight feet. On the initial test it produced 72 bbl. of crude in one hour through 3/16-in. choke.

●

The Amerada Petroleum Corporation's No. 1 Weil, in eastern Rapides Parish, Louisiana, has opened a new pool. The test was drilled to a depth of 6837 ft., but was plugged back to 5712 feet. On a test made through perforated casing at 5705-10 ft. it flowed 141 bbl. of oil in 22 hours through ¼-in. choke. This is the first production along the Conroe trend in Louisiana and for that reason is regarded as highly important.

●

Completion of two wells to the east of the Fitts pool has given an important extension to that field. Skelly Oil Company's No. 1 Park College, a quarter of a mile east of production, was drilled to a total depth of 4275 ft. and is producing from the McLish. The first hour it flowed 786 bbl. of oil.

J. E. Crosbie, Inc.'s No. 1-A Burris Heirs, approximately a mile east of the Park College well, is considered the more important of the two. It flowed 850 bbl. the first hour after being brought in and is drilled to a total depth of 4260 ft. in the McLish.

●

A showing of oil in Herton Oil Company's No. 1 Roane indicates a new pool in St. Mary Parish, Louisiana. A drill stem test was made from 7460 to 7512 ft., and with the show of oil plans were being made to take a production test.

●

The Seven Sisters field of Duval County, Texas, has been given a mile and a half extension by Harvey & Henderson's J. F. Welder Heirs No. 1 drilled to a depth of 2431 ft. in the Government Wells sand.

AVERAGE CRUDE PRICES

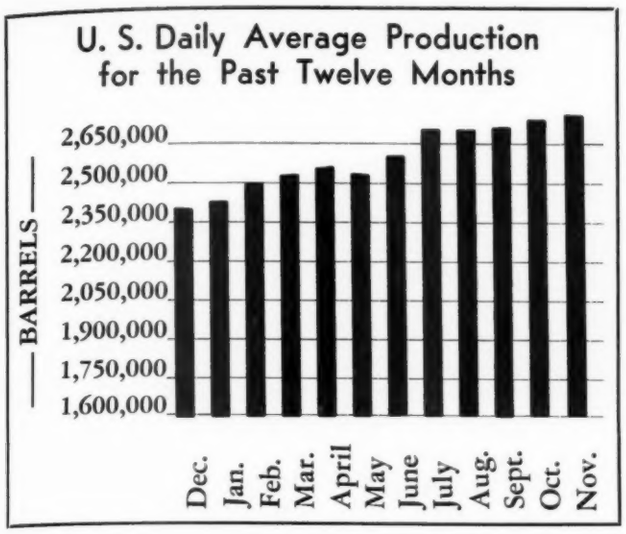
California	
Kettleman Hills	$ .91-$1.11
Playa Del Rey	.87
Coalinga	.76
Signal Hill	.86
Montana	1.35
Wyoming	1.00
Colorado	1.00
New Mexico	.75
Texas	
North Central	.95
Panhandle	.51-.71
West Texas	.70-75
Gulf Coast	1.04
Darst Creek	.87
East Texas	1.00
Kansas	1.00
Oklahoma	1.00
Arkansas	.70
Louisiana	
North Louisiana	$ .95
Gulf Coast	1.04
Illinois	1.13
Kentucky	1.13
Indiana	1.12
Ohio	
Lima	1.15
Michigan	1.12
Pennsylvania	
Bradford	2.30
Southwest	2.02
Eureka	1.97
Buckeye	1.82
Corning	1.32
West Virginia	1.67
Canada	2.10-2.17

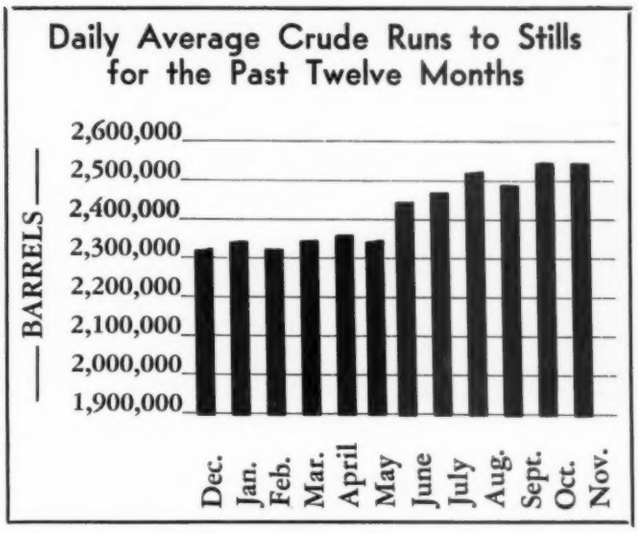
DAILY AVERAGE CRUDE OIL PRODUCTION

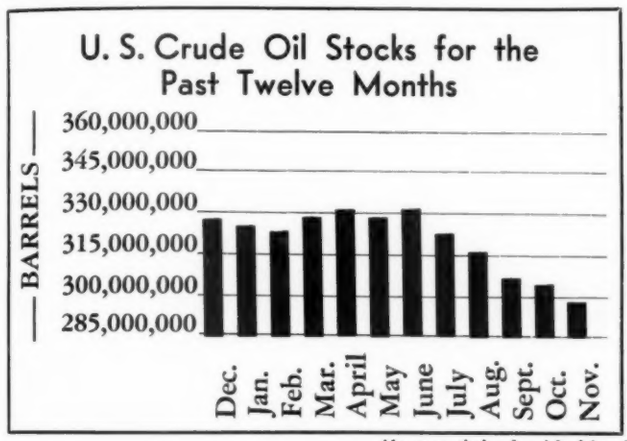
Furnished by A.P.I.

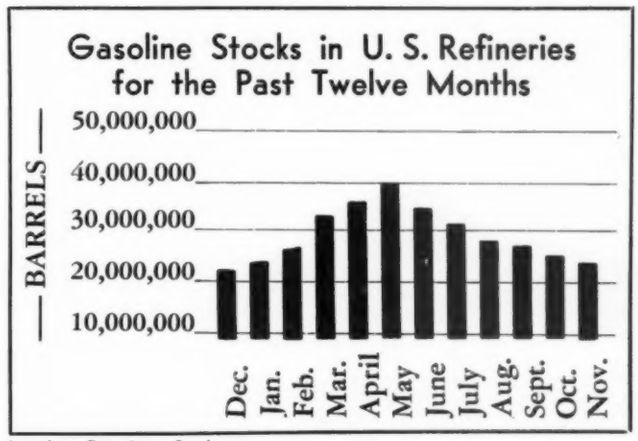
(Figures in Barrels)

	B. of M. Dept. of Interior Calculations (November)	Week Ended Nov. 30 1935	Week Ended Oct. 26 1935	Week Ended Dec. 1 1934
Oklahoma	492,000	484,700	499,900	463,600
Kansas	143,300	145,800	150,950	127,200
Panhandle Texas	....	67,100	56,050	59,800
North Texas	....	59,800	59,050	54,400
West Central Texas	....	25,650	25,550	27,500
West Texas	....	165,250	155,450	138,800
East Central Texas	....	45,400	45,950	43,100
East Texas	....	434,000	428,250	413,200
Southwest Texas	....	64,050	60,900	61,150
Coastal Texas	....	206,700	193,350	164,000
TOTAL TEXAS	1,027,000	1,067,950	1,024,550	961,950
North Louisiana	....	34,550	32,100	24,000
Coastal Louisiana	....	126,700	124,850	82,850
TOTAL LOUISIANA	127,100	161,250	156,950	106,850
Arkansas	29,100	29,700	30,150	31,150
Eastern	97,700	104,700	106,250	108,550
Michigan	40,400	49,650	54,500	26,900
Wyoming	33,900	36,550	40,800	36,650
Montana	11,400	13,150	12,850	11,900
Colorado	4,000	4,150	4,400	3,200
New Mexico	52,200	57,850	56,950	45,750
TOTAL EAST OF CALIF.	2,058,700	2,155,450	2,138,250	1,923,800
California	505,000	665,000	659,700	448,900
TOTAL UNITED STATES	2,563,700	2,820,450	2,797,950	2,372,700









Above statistics furnished by the American Petroleum Institute.

Summarized Operations in Active Fields for November, 1935

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	219	212	81	139	3600	2	40	Rotary
Duval County	64	58	12	20	2300	2	22	Rotary
Archer County	34	16	6	30	660–1800	1 or 2	40	Rot.-Cab.
Conroe	1	1	0	1	2000–7400	3 or 4	40	Rotary
Panhandle	55	54	43	127	2200–3900	2	40	Rotary
Refugio County	3	3	1	2	5200	2	38	Rotary
Oklahoma								
Oklahoma City	12	8	6	44	6500	3	39	Rotary
Pontotoc County	27	22	13	58	1800–4488	2 or 3	38	Rotary
Osage County	30	23	7	56	380-2850	2	37.5–40	Rot.-Cab.
Kansas								
McPherson County	3	2	2	10	2900–4300	2	38	Rot.-Cab.
Harvey County	1	1	1	3	3450	2 or 4	37	Rot.-Cab.
Ellsworth Arch	29	18	25	91	3300	4	37	Rot.-Cab.
California								
Kettleman Hills	2	2	6	24	8300	3 or 4	40	Rotary
Long Beach	5	5	4	37	7000	3	36	Rotary

Field Activities by States for November, 1935

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1934 (In Barrels)
	November	October	November	October	November	October	November	October	November	October	
Arkansas	7	9	1	3	8	5	12	11	33	27	11,412,100
California	50	82	46	69	78	74	70	73	246	261	175,678,362
Colorado	1	1	1	1	....	....	2	4	28	27	1,168,000
Illinois	2	3	2	3	....	....	12	14	12	13	4,466,000
Indiana	3	12	1	1	....	....	4	1	52	50	813,000
Kansas	89	114	60	78	125	84	34	29	221	207	45,577,050
Kentucky	13	15	8	11	....	....	3	4	6	12	4,863,000
Louisiana	48	49	33	32	63	59	44	46	141	132	32,572,900
Michigan	62	47	42	28	83	86	92	95	124	113	10,589,600
Mississippi	....	2	....	1	....	....	2	1	8	9	Gas. Prod.
Montana	20	19	16	15	....	....	7	10	66	56	3,797,000
New Mexico	27	18	23	16	....	....	13	10	103	99	16,529,050
New York	....	....	....	....	....	....	1	0	8	6	3,880,700
Ohio	119	113	80	72	....	....	35	20	135	118	4,291,000
Oklahoma	166	211	106	141	241	184	93	54	527	527	176,506,550
Pennsylvania	9	11	5	11	....	....	26	23	103	97	15,353,850
Texas	846	788	632	609	2184	882	337	329	1037	1056	380,848,000
West Virginia	44	49	36	42	....	....	23	27	81	81	4,043,550
Wyoming	7	6	7	5	....	....	6	11	73	64	12,371,100
Totals	1513	1546	1099	1135	2782	1374	816	748	3004	2950	903,350,812

THE MONTH'S ACTIVITIES IN REFINING

Percent Refinery Capacity Operated

Western Division, 71.5 percent **Central Division, 73.2 percent** **Eastern Division, 78.5 percent**

THE Standard Oil Company of California has announced it will construct a refinery on the island of Bahrein in the Persian Gulf. Initially the plant will have a capacity of 10,000 bbl. daily, and the design of the refinery will be such that the capacity can be easily doubled when desired. Gasoline, kerosene, Diesel oil, and fuel oil will be the principal products manufactured. Work will start shortly on the erection of the plant, orders for equipment already having been placed, with completion of the project expected for next July.

The Standard Oil Company of California acquired a concession of 100,000 acres in Bahrein in 1930, and through its subsidiary, the Bahrein Petroleum Company, has developed an oil field of considerable proportions. The discovery well was brought in in June, 1932, and there are now 16 producing and six drilling wells. Production recently has approximated 6500 bbl. of crude daily.

A refinery at Bahrein will be well situated with regard to markets. There is a large consumption of petroleum products in countries eastward to Singapore, including India, with its population of 400,000,000; westward to Suez, and south along the east coast of Africa and South Africa. Possibilities also are good for development of trade in the far east.

●

A new refinery has been completed and put into operation at Carson City, Michigan, by the Crystal Refining Company. Crude from the Crystal pool is being used exclusively, 1500 bbl. per day being processed. In addition to other equipment two 500-bbl. agitators have been installed, and the plant is making gasoline, kerosene, and distillate.

The plant was designed and constructed by E. G. Guy, who has built numerous refineries in the State of Michigan.

●

A natural gasoline plant having a capacity of 12,500,000 cu. ft. of gas daily is being constructed in Gregg County, Texas, by the Gilliland interests, of which J. W. Gilliland is president. It will be of the compression type and will be connected to approximately 1400 wells. Present plans call for the plant to be in operation early in January.

●

The Marathon Oil Company has acquired from the Texas Pacific Coal and Oil Company considerable of the equipment of the T. & P. refinery at Fort Worth, Texas, which is being dismantled. The Marathon also has taken over the crude oil connections of the T. & P. in the Ranger and other north central Texas fields, and has entered into an agreement to supply petroleum products to all T. & P. service stations in northern Texas.

●

The Wood-Moore Corporation has announced they will construct a 2000-bbl. capacity refinery at Port Lavaca on the Texas Gulf Coast, work to start immediately. Initially but 1250 bbl. of crude will be processed daily, but the plant will be so designed that additional equipment can be added on short notice to bring it up to the 2000-bbl. capacity. The 42-gravity crude produced in the area favors the manufacture of closely fractionated naphthas and solvents.

The contract for the engineering work and materials has been awarded to the Vulcan Steel Tank Corporation. R. B. Millard will supervise the construction. The plant is expected to be completed by September 1, 1936.

●

The Dickey Oil and Refining Company of Wichita, Kansas, is making improvements to its refinery at McPherson, Kansas. The Webster Engineering Company of Tulsa, Oklahoma, has the contract for making repairs and installing new equipment. Officials announce that sufficient gasoline and petroleum products are in stock to care for the company's business while plant operations are curtailed.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending November 30, 1935

A. P. I. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	493,000	80.6	11,964	11,559
Appalachian	94.8	111,000	76.0	1,806	955
Ind., Ill., Ky.	95.9	334,000	78.8	7,264	3,892
Okla., Kans., Mo.	84.8	232,000	60.4	4,815	4,610
Inland Texas	48.5	97,000	60.6	1,185	1,702
Texas Gulf	96.8	615,000	93.5	4,938	10,778
La. Gulf	96.4	138,000	84.7	1,110	4,994
No. La.-Ark.	90.0	48,000	66.7	245	540
Rocky Mt.	61.9	46,000	76.7	715	771
California	92.6	522,000	66.2	9,148	66,480
TOTALS WEEK:					
Nov. 30, 1935	89.6	2,636,000	76.0	43,190	106,281
Nov. 23, 1935	89.5	2,575,000	75.6	41,924	106,778

What Oil and Gas Association Means to California Industry

By F. E. FOSTER

Managing Director, California Oil and Gas Association

F. E. FOSTER

AN industry, like a nation, needs clearing houses of varying geographical coverage and purpose, corresponding after a fashion to the several types of governmental bodies. Such organizations are particularly useful when problems that affect a wide segment of the industry raise their heads. In the oil industry our clearing houses are the oil and gas associations.

In California the oil industry has had the advantage of association work since 1906. In its broadest aspect such work is the generating of a spirit of confidence and coöperation throughout the industry. An oil association offers a medium for everyone engaged in the industry to meet and discuss problems common to all, and to unite in solving these problems. Nationally, of course, we have the American Petroleum Institute as the great prototype of all local associations.

In California, whenever the oil industry finds it necessary to take concerted action (and that necessity is always present in some department), there is always an oil association to provide the means. Thus, for example, in 1923 the industry was confronted with an overproduction situation, following the bringing in of the three great fields, Long Beach, Huntington Beach, and Santa Fe Springs. Under oil association sponsorship the companies were brought together, a plan of stabilization was worked out, and the situation was saved. Five years later, in 1928, the first steps toward state-wide limitation of production were taken under association sponsorship, and in 1929 the basis of a practical proration program was devised.

As in overproduction, so in nearly every other problem of general importance oil associations provide the means for solution. The A. P. I. standardization program, which has saved the industry millions of dollars during the past ten years, is handled in each state by local committees and organizations. In California the work is done by oil association committees reporting to their parent body, which in turn reports to the Institute. Without the constant impetus of a local association behind them, these committees would find it much more difficult to organize and to function.

In the field of legislative investigation it is necessary that the industry, if it is to keep abreast of the flood of bills introduced in municipal, county, state, and Federal governments, have some central group constantly on the alert. The California industry has such a group, and naturally it is a division of an oil association. No one man, no one company, could hope to sift the thousands of bills introduced in the various legislative bodies and analyze the implications of each. An oil association, on the contrary, through committees made up of representatives of several companies, is in a position to appraise each bill impartially.

So, also, in the important field of public relations, any one company can accomplish but little for the industry as a whole, and indeed has no reason and should not be expected to attempt more. Yet there is a message that the industry as a whole has to tell the public, to erase misunderstanding and to win for the industry the good will of those who buy its products. Public good will, based on appreciation of the problems and hazards of the industry, means sympathetic attention when the industry asks for consideration; it means intelligent understanding of the industry's objection to inequitable taxes; it means realization that overtaxing the oil industry is one way of hampering the general prosperity.

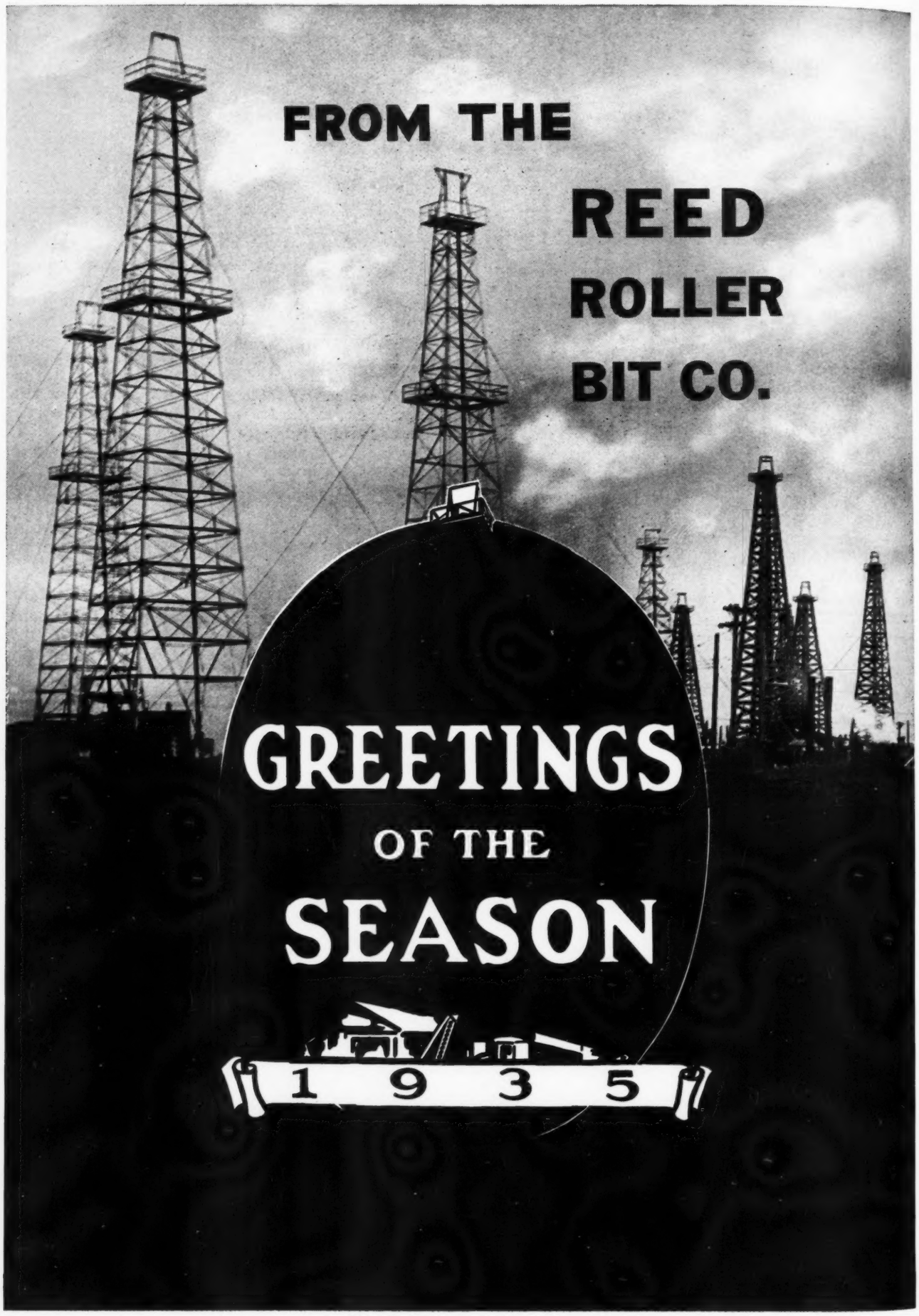
Even now in California there is a projected public relations plan, an oil association plan, that will begin to function in the near future, probably soon after the A. P. I. annual meeting, the meeting providing part of the inspiration. The thought is to portray to the public in all the five western states, in an active, aggressive effort to reach every gasoline user, the story of the oil industry as it is. It is hoped that the campaign will portray the long chances that oil operators are forced to take, the hardships and handicaps undergone as a matter of course in prospecting, the magnitude of the task of drilling a wildcat or any other well, the incidental labors that the average man never hears of (building roads, for example, or developing water supplies, or erecting proper housing), and the expensive and disheartening chances and operations necessary at every step of the way from the well to the gasoline pump.

The subject of taxation is one that continually agitates the oil industry. Except through the medium of its associations, the industry could never hope to know its own mind in regard to any particular piece of taxation legislation, much less to take any steps for expressing its views. As it is, taxation committees are forever examining new legislation, comparing tax schedules for different areas and different years, preparing analyses of the effect of excessive taxation on the sale of various products and on general prosperity.

Another project of value to the entire industry, and one that could never have been accomplished by individual company action, is coöperative fire protection. Through an oil association committee, on which every company concerned has a representative, all the oil-company fire equipment in the Los Angeles Basin, together with the location of such equipment, the names, addresses, and telephone numbers of those in charge of the equipment, maps of oil districts, data on the assistance obtainable from the railroad companies, and master maps of every community through which oil pipe lines run, showing the location of lines and valves, is indexed in a reference book.

These are but typical examples of oil association work being accomplished in California. The survey could be extended. If completed, it would include such subjects for action as harbor rates, pipe line franchises, transportation problems, aviation promotion, and waste water disposal. In each of these fields of inquiry the California oil industry is working through the medium of oil associations to accomplish the greatest good for all.

The conclusion of this essay must be that the California oil industry, in its never-ending struggle to achieve economic stability and economical operation, has organized and utilized oil associations as a matter of course. That the industry appears to be in an eternal state of upheaval is no indictment of the associations. Whenever any industry becomes permanently tranquil, that industry may be regarded as moribund. Rather, the existence of the associations (trouble-shooters is actually what they are) is proof that the industry is very much alive; that it is wrestling with its problems in the most efficient manner it can contrive.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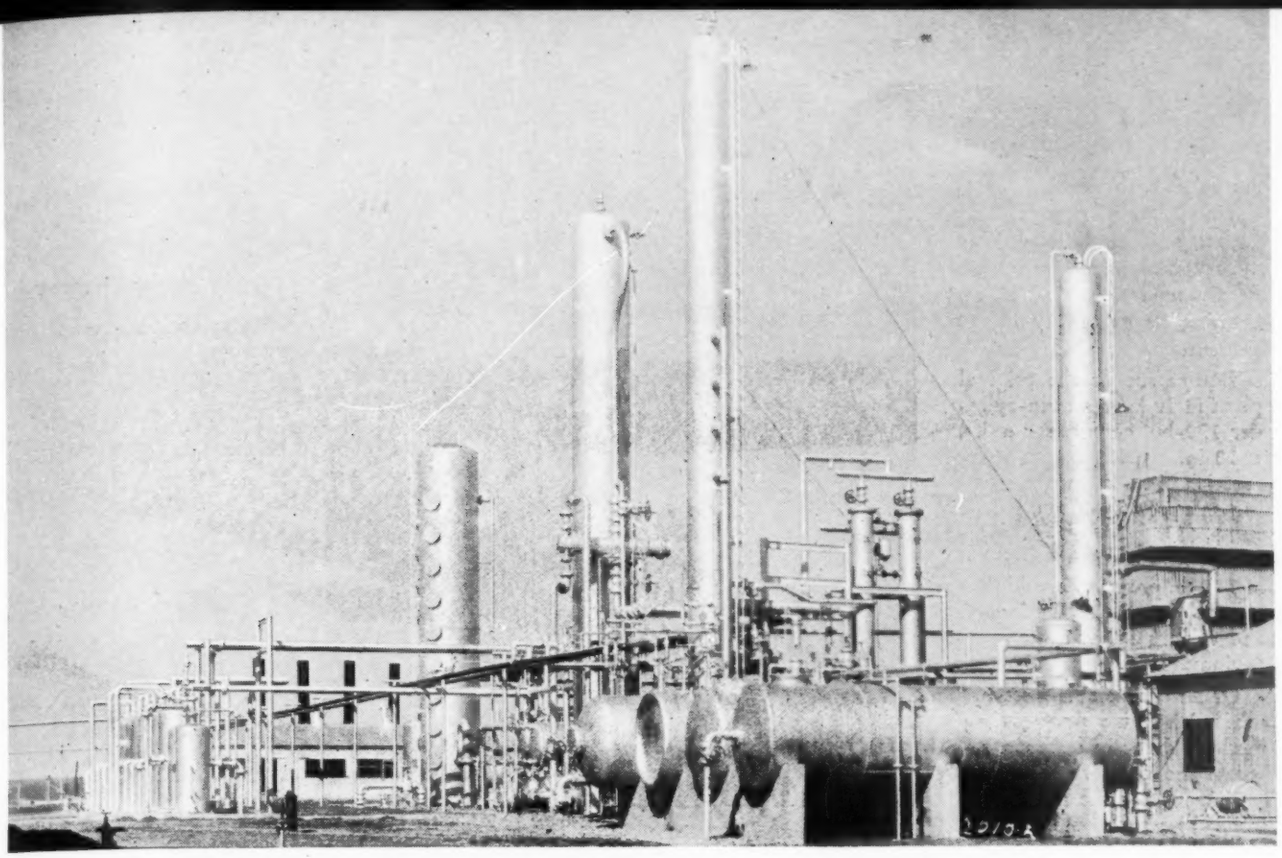


View showing discharge scrubbers, absorber, gasoline fractionator, gas rectifying tower, expander units, still and dephlegmator, reflux storage, and accumulator tank

First High-Pressure Gas-Rectifying Plant in Oklahoma Converted into Combination Gas-Rectifying and Absorption Plant

By FRANK H. LOVE

Decline of field necessitated change to low-pressure system and elimination of 2-stage compression

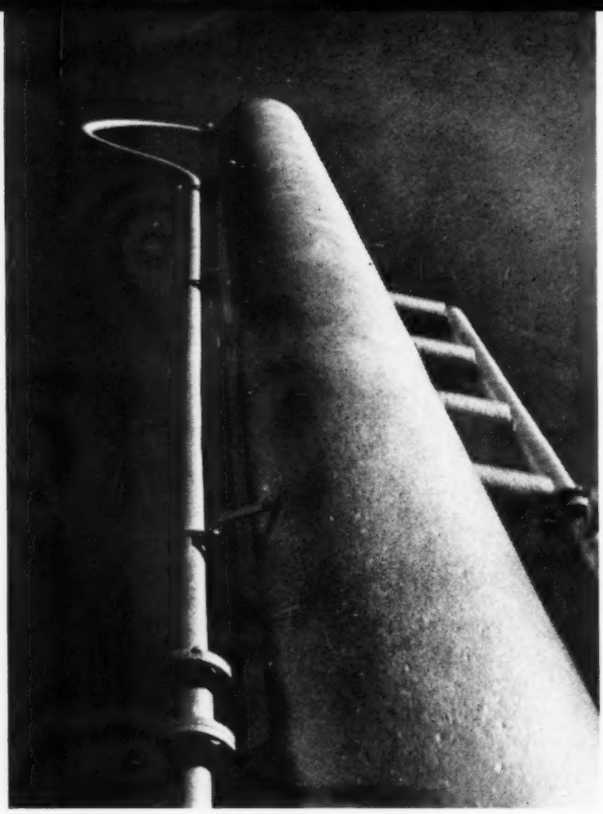
CONSTRUCTED originally as a high-pressure gas-rectifying unit, the Fairfax (Oklahoma) gasoline plant of the Skelly Oil Company has been converted into a combination gas rectifying-absorption plant.

When erected approximately a year and a half ago it had the distinction of being the first gas fractionating type plant in the State of Oklahoma and one of the few in existence. This type equipment was selected by officials of the Skelly organization following a comprehensive study of the characteristics of the casinghead gas in the area, keeping in mind that the plant's excess residue gas was to be sold to the Kay County Gas Company and had to be boosted to a pressure of 300 lb. per sq. in. for delivery. It was determined upon as the most economical type plant to meet these conditions.

The plant differed from those in general use in that the gas was sent directly to a fractionating column as a gas rather than as a liquid. From there it was taken to a regulation fractionating column and made into the finished product.

Subsequently the field from which the supply was obtained declined to a point where it was necessary to two-stage the gas in order to employ the existing system, the first stage compressing it to 50 lb. per sq. in., the second to 300 pounds. It was decided then that it would be advantageous if a plan could be worked out whereby it would not be necessary to two-stage the gas, handling it but once and at a pressure of approximately 40 lb., with more of the residue being returned to the field for repressuring purposes. As a result absorption equipment was installed to assist in carrying the load, the gas-rectifying unit continuing to operate at capacity.

The addition of the absorption unit has necessitated the installation of five new twin-cylinder 170-hp. compressor units, as well as a 42-in. by 43-ft. combination still and dephlegmator designed to strip 200,000 gal. per day of 190 molecular weight absorption oil. This unit operates under approximately 40-lb. pressure and at a temperature of 345 deg. fahrenheit. Four of the new engines have 17-in. by 20-in. compressor cylinders, and one has 7¼-in. by 20-in. cylinders. In connection with the new set-up three 7½-in. by 7-in. by 10-in. duplex oil pumps have been added, and three 8-in. by 8-in. by 10-in. steam reciprocating pumps for circulating



This absorber has an 8,000,000 cu. ft. daily capacity

water, as well as an absorber having 8,000,000 cu. ft. daily capacity. The atmospheric type water-cooling tower has been extended 24 ft. also, increasing its capacity by 30 percent.

Equipment in the original plant included ten twin-cylinder 170-hp. compressor units, a 30-in. by 52-ft. gasoline fractionating column operating on a pressure of 200 to 250 lb., a 48-in. by 45-ft. gas-rectifying column operating at 300 lb. pressure, in addition to a cooling tower, scrubbers, and various other auxiliary equipment.

Under the existing set-up, while the two processing methods differ in certain respects and require separate equipment for the most part, stock from both systems passes through the gasoline fractionating column for final treatment.

Scrubbers provided consist of two 5 by 20 units on the inlet headers, and one on the outlet, in addition to the numerous smaller units on the discharge of the engines.

An auxiliary building houses two 80-hp. engines driving a lineshaft, used for generating power for lights, and for water circulation.

The gas in the area from which the Fairfax plant obtains its supply, although sweet, is somewhat lean, making approximately one gallon of finished product per 1000 cu. ft. of gas. An analysis of an average sample shows the gas to contain the following components:

Component	*Mol Percent*	*Weight Percent*
Methane and Lighter—	63.1	38.8
Ethane—	15.5	17.8
Propane—	11.7	19.7
I-Butane	2.3	5.1
N-Butane—	4.0	9.2
Pentanes—	3.4	9.4
	100.0	100.0

From 12,000 to 13,000 gal. of 26-lb. natural gasoline are being manufactured daily, requiring 10,000,000 to 11,000,000 cu. ft. of casinghead gas. Approximately 50 percent of the latter is returned as residue gas to a lift station operated by the unit for repressuring in the field, a part is utilized as fuel, and, as aforementioned, the remainder is sold commercially.

The Fairfax plant has been provided with a 100,000-gal. gasoline storage, but the bulk of the finished product is pumped through a 3-in. pipe line to the Lyman plant of the company, a distance of 12 miles, and marketed from that point.

General view of Skelly Oil Company's Fairfax gasoline plant

Casing Pumps in Winkler Field

Pumps of large diameter employed to handle large volume of fluid. No increase in size of sucker rods necessary

By J. C. ALBRIGHT

Well in the Winkler field equipped with casing pump for handling large quantities of fluid

THE Winkler, or Hendrix field, near the town of Wink, in Winkler County, West Texas, occupies the unique position of producing more water per bbl. of pipe line oil than perhaps any other field in the world today. It has been estimated by reliable engineers that a total of approximately 500,000 bbl. of water is taken every 24 hours from the wells still producing in the field. This field, discovered in 1926, had at one time approximately 500 producing wells, but due to the rapid encroachment of formation water, the number now being operated will not exceed 400. Oil production during the peak of the field in 1929 averaged 12,000 bbl. per well, and one, Cranfill & Reynolds Hendrix C-1, made 98,000 bbl., estimated from a one-hour flow test.

During the peak year of production and those immediately preceding, water had not become a serious problem, but the latter part of 1928 and early in 1929 water encroachment began to cause alarm. If water continues to be produced at the present rate, a volume of that fluid will have been produced and disposed of equal to the entire oil production from the discovery in 1926 to the end of 1934. Production of pipe line cil for the field by years is as follows:

Year	*Production*
1926	5,178
1927	3,650,295
1928	57,746,889
1929	50,050,973
1930	26,236,830
1931	15,295,954
1932	10,742,061
1933	8,256,000
1934	7,685,850
Total	179,670,030

The fluid level in a large part of the field is near the surface, and most of the wells are still flowing. In some instances, however, the fluid level is down about 1000 feet. When running tubing in some of the wells, the fluid level being near the top of the casing, water and oil will slop onto the derrick floor when each successive joint, or stand, is run into the hole. Since those wells that have ceased to flow because of the tremendous static head of formation water are still considered profitable producers of oil, a large number has been placed on the pump; but because of the tremendous volume of water coming with the small percentage of oil, larger pumps and working barrels have been resorted to in an effort to maintain or increase the production.

Several different types of pumps are in use throughout the field, and the edge wells are being produced with conventional hook-ups of tubing and rods. Those wells that have a large amount of water coming from the lime with the oil are being produced satisfactorily with the large-diameter casing type of pumps.

This type of pump is being used quite extensively by the various producers in the field. Several months ago 65 of these pumps had been installed during the past year, and a list follows, showing the company and number of pumps operated by each at that time:

Stanolind	16
Lion	16
Shell-Texas	8
General Crude	5
Humble	5
Gulf	3
Continental	3
California Company	3
Republic	2
Skelly	2
Sinclair	1
General Petroleum Exploration	1

This pump employs no tubing, but has the working barrel assembly inserted in the casing of the well, anchored at the depth desired for operation, and packed off at the top by a special Duprene packer. It is anchored at the point desired by use of a tubing catcher. Any size working barrel may be used with this type of pump, employing the usual size and type of sucker rods.

The outer casing of the pump is usually the size that will enter the casing of the particular well being equipped, with a special swaged nipple mounted on the lower end, to which

This shows a well in the Winkler field equipped with casing pump and the type of power unit used for pumping

the tubing catcher is attached and adjusted. The working barrel is inserted with a standard standing valve, but it has been found that the lighter weight, poppet type of valve is more efficient than the usual ball and seat. The cups and traveling valve are fitted to a pony rod, which in turn is connected to a polished rod in the assembly. The working barrel is connected to an adapter nipple fitted in the upper end of the casing of the pump. Built into the pump is a special unloading device, which is called the drain sleeve with the Duprene packer fitted to the upper end. The pump head is constructed so that it slides up and down easily when being run, but sufficiently heavy that when in operation, it will set down in the drain sleeve so that the unloading ports are closed.

The pump assembly, after being adjusted, is run into the casing of the well on sucker rods attached to the polished rod and anchored at the desired depth in the well in the same manner that a string of tubing is anchored when using the tubing catcher; then the rods are "bumped" down to determine the position of the traveling valve in relation to the lower end of the working barrel. As no tubing is used, the polished rod is fitted through the stuffing box, attached to a swaged nipple in the top of the casing. The lead line is usually 4-in. or 6-in., depending upon the size and volume of the pump, and is connected to a fitting placed on the well casing either over or under the derrick floor.

If for any reason it is desired to pull the casing barrel and rods, the usual method is followed out, after breaking the seat of the tubing catcher. The first pull of the rods when coming out of the hole, raises the working barrel pump head and polished rod stuffiing box, which in turn lifts the drain sleeve slide. This action uncovers the drain sleeve, or unloading ports, and permits the column of fluid above the traveling valve to reach equilibrium with the head of fluid in the well. The fluid above the Duprene packer drains through the ports and thus permits the fluid to return to the well outside the casing pump.

Stanolind has 16 of these pumps in operation, all of which naturally have been checked for efficiency as against the usual type of tubing pumps. This company operated a 5-in. casing pump for a period of 225 days in its Hendrix T-88-U-3 well and produced for the 225 days a total of 24,975 bbl. of oil.

Data concerning the operation of an ordinary 3-in. tubing pump for 225 days immediately preceding installation of the 5-in. casing pump was referred to in order to check the results with the casing pump. The well showed that during the 225 days previous to July 5, 1934, the date the casing pump was installed, it produced 18,390 bbl. of oil.

Pulling costs for the well when equipped with the ordinary string of tubing were $47, or an average of $0.213 per day. The period following showed that pulling costs were $346, or an average of $1.33 per day; however, the increase in net production shown by the company records was $17.30 per day.

This well was operated with the same size string of sucker rods with both types of pumps. The pump operates at 20 strokes per minute with a 54-in. stroke. The production figures are actual, and do not take into consideration the natural decline of the well over the two periods of 225 days each.

Gulf Production Company proposed about January 1, 1935, to install a casing pump in its Hendrix A-2, and conducted a production test with the usual 4-in. tubing and 3¾-in. working barrel that were being used in the well. For the

Two wells in the Winkler field making approximately 97 percent water and only 3 percent oil flow into this sump

Stream of water produced from one well in the Winkler field

24 hours during this test, the well made 1556 bbl. of water and 145 bbl. of oil on a 72-in. stroke, and at 21 strokes per minute, and with the tubing set at a depth of 2004 feet. Immediately after the test, a 4-in. casing pump with a 3¾-in. working barrel was installed, set at 1985 feet. It was operated with the same string of ⅞-in. sucker rods at the same speed as before and having the same length stroke. For the 24 hours on test, the well made 1806 bbl. of water and 179 bbl. of oil. The rig is a standard one, using a gas engine for power.

Shell Oil Company tested its Hendrix A-2 well from February 5 to 15, after a 4-in. casing pump had been installed. The pump was anchored at 1950 ft. and operated with a 48-in. stroke at 22 strokes per minute. Each day during the test the well made 118 bbl. of oil and 3024 bbl. of water. The pump was operated by a Lufkin unit driven by electric motor and 15.3 hp. was required at the time of test. The power consumption was 11.5 kw-hr., and the February billing for power was $140.97. The records of the company show that the lifting cost was $0.0015 per bbl. of fluid, and $0.0398 per bbl. of oil. The power requirements for lifting a barrel of fluid was shown to be only .0908 kw-hr., but as only about four percent of the volume lifted consisted of oil, the requirements for power when reduced to terms of pipe line oil was 2.33 kw-hr. per barrel.

Pulling costs, when considered generally from records of the companies operating the casing type of pump, do not vary considerably from the cost of ordinary pulling tubing and rod jobs. Difficulties encountered in fishing out broken and parted strings of sucker rods are not any more complicated with rods loose in the casing than when the same condition is found in tubing. When these casing pumps were first used in the Hendrix field, it was thought by some that difficulties would be encountered that would be serious when fishing out broken strings of rods. The employees of the companies who are pumping large quantities of water with the oil with the usual type of tubing and rods are familiar with the requirements when recovering broken strings of rods. After being instructed in the method of recovering rods from the open casing, the job of fishing is as easy as in tubing of small diameter. The usual fishing tool is used when fishing rods from casing, but a swaged nipple is fitted to the lower end of the tool, which slips easily through the casing. When the fishing tool comes in contact with the broken box or part of the rods, the swaged nipple acts as a guide to the fishing tool and the rods are recovered in the usual manner.

These pumps are designed and manufactured so that standard drops and seats may be used, together with the usual types and makes of cups and parts that may be purchased at any oil field supply store.

High-Pressure Manifold on Gas Well

HERE is shown a special manifold and heater on a high-pressure gas well in the Placedo field, Texas Gulf Coast. The well has a closed-in pressure of 2000 lb. and a working pressure of 1600 lb., which is reduced to 500 lb. by means of chokes. With this hook-up, designed by the Oil Center Tool Company, gas is supplied to four drilling wells. Gas for the heater, part of which is seen in the lower right-hand corner of the picture, is obtained from the low-pressure side of the manifold. On the left can be seen the gas connection, with regulator and tank, to the heater—used to prevent freezing.

Controlled Directional Well-Drilling and Surveying Practice

By
JAMES D. HUGHES

Part V

SOME of the special bits used in controlled directional drilling are:

1. Follow-up bit. Fig. 26.
2. Pilot reaming bit:
   (a) Soft formation. Fig. 27.
   (b) Hard formation. Fig. 28.
3. Spoon-bill bit. Fig. 29.
4. Pineapple bit. Fig. 30.
5. Disc bit. Fig. 31.

Each of these bits has a distinctive use and place in the practice of the art. Other bits are of course used in the course of normal drilling but they are conventional types and therefore not subject to discussion.

The Follow-up bit shown in Fig. 26 is the outgrowth of study and observation of numerous experimental types. In it are incorporated those features most to be desired, namely: ability to carry weight without excessive penetration, directional stability (minimum "walking" tendency), and freedom from excessive balling up.

As its name implies, it is used to follow up the run of the whipstock bit. Its diameter is slightly smaller than the whipstock bit and it is most often run on a double of 3½-in. drill pipe. Owing to its design, the application of weight while drilling causes the pipe to bow out as illustrated in Fig. 25 and thus build up the angle initially imparted by the whipstock. The number of feet drilled with this bit depends upon the length of the joints, the position of the kelly and the length of the whipstock being sufficient to have a full kelly up if it became necessary to set another whipstock.

The Pilot reaming bit shown in Fig. 27 is used to ream out the deflected rathole to gauge. This bit is also the result of experiment with various types and embodies those features found to be essential. It, as well as the other bits of special design, is of the box type connection, which eliminates a great deal of sub difficulties. The pilot portion extends 21 in. below the reamer and carries a diamond-point or mule-shoe bit very dull on bottom. This pilot bit carries no circulation holes; the circulation is obtained from the mud courses on the reamer blades where the actual digging occurs. The kelly is marked as an aid in determining if the pilot is actually in the rathole. As a further precaution the pipe is rotated and, if the pilot is not in the rathole, causes the dull bottom to "walk" around until it does fall in . . . a happening that is apparent at the surface. The X-type construction of the reamer blades tends toward a smoother and more efficient cutting action.

The Pilot reaming bit shown in Fig 28 was developed in

Fig. 26. Follow-up bit

Fig. 27. Pilot reaming bit for soft formation

Fig. 28. Pilot reaming bit for hard formation

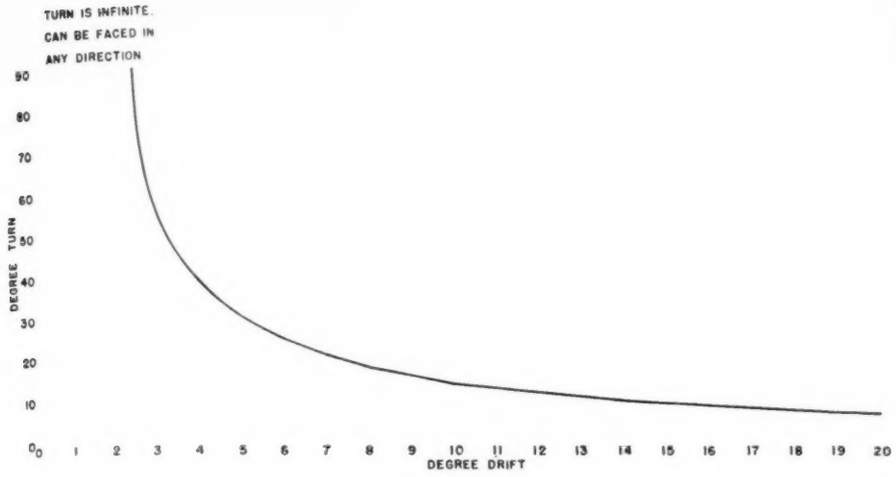


Fig. 32. Curve showing relation between drift angle and theoretical turn from whipstock with 2½-deg. dog leg

conjunction with a leading rock bit manufactured to accomplish the same results in hard digging where a rock bit had been used off the whipstock.

The Spoon-bill bit, Fig. 29, has long been used in deflection work in California. It is also run on a limber double. Its peculiar construction lends itself rather well to the application of a great deal of weight while drilling. It has been found to generate a left-hand turn to the drilled hole. This turn is usually accompanied by a loss in drift angle. When it does not develop a left turn, as is frequently the case, it builds up drift angle.

Another bit, the Pineapple, as pictured in Fig 30, is frequently used to build up drift angle. This is accomplished more quickly when made up immediately below a three-point conventional reamer.

Disc bits of the type shown in Fig. 31 have been found the most consistent bit means of generating left-hand turn. The angle at which the cutter wheels attack bottom probably has more to do in making this type preferable for left-hand turn over those bits whose cutters are set vertically. In the latter type the turn, if any, is slower.

Use of the last three novelty bits described is generally confined to those operations having a great deal of vertical working space in which to accomplish a minimum and non-specific deflection. As a whole they are not to be depended on for any one specific result but are run under the best possible conditions favorable to their action as a gesture in economy. Weight and speed of rotation are the two most important factors in their successful use and these vary widely with local conditions.

The second requisite in the practice of controlled directional drilling as previously outlined is the means of setting the whipstock so that it will drill off in the required direction.

In a reasonably vertical hole (up to two degrees) a whipstock can be set to drill off in any given direction. As the drift angle of the hole increases the minimum theoretical turn that can be obtained from a whipstock without altering the drift angle decreases as can be seen from the following tabulation based on a whipstock dog-leg of 2½ degrees. The turn is greater when the whipstock is set to lose drift at the same time and less when set to build up angle.

Angle of Hole	*Min. Turn*
3 deg.	56 deg.
5 deg.	30 deg.
10 deg.	14 deg.
20 deg.	9½ deg.
25 deg.	5¾ deg.
30 deg.	4¾ deg.

Fig. 32 illustrates this relationship under the above conditions in graphical form.

The direction that a whipstock must be faced in order to drill off in the required direction is arrived at by an analytical construction of vectors, described as follows:

To determine a setting by this method the drift angle and bearing of the hole at the setting point and the whipstock dog-leg (built in angle) are required.

Procedure:

(1). Lay off on coordinate paper the polar axis and label North, South, East, and West.

(2). By means of a protractor lay off a line corresponding to the bearing of the hole. Taking a convenient scale, 1 inch = x degrees, make this line as long as the numerical value of the drift angle. Designate this line "O-A", "O" being the intersection of the polar axis.

(3). Take a compass and describe about "A" a circle whose radius equals the numerical value of the whipstock dog-leg using the same scale as before.

(4a). If a certain drift angle is the required result of the setting, describe an arc whose radius equals this required angle about "O" so as to interesect the dog-leg circle about "A" at two points. If the hole is to be turned to the left, the left-hand intersection is used; opposite, if right. Then draw from "O" a line to this intersection point and call it "O-B". This line "O-B" will be the resultant drift and bearing of the sidetrack hole. Use the protractor to deter-

Fig. 29. Spoon-bill bit

Fig. 30. Pineapple bit

Fig. 31. Disc bit

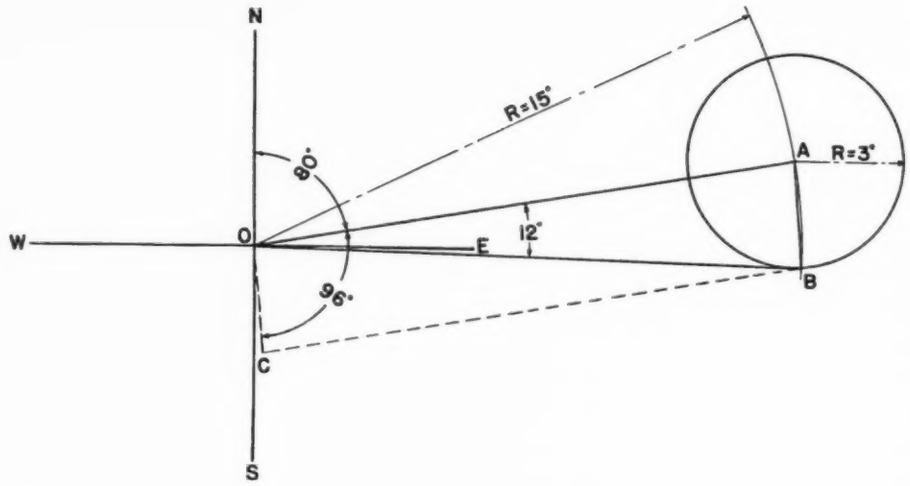


Fig. 33. Determining whipstock setting by vectors

mine the bearing and the same scale to determine the drift angle.

(4b). If maximum turn is required, draw a line from "O" tangent to the dog-leg circle to the left or right as desired and call this point of tangency "B". Measure the resultant "O-B" as before to determine bearing and angle of side-track hole.

(5). The figure "O-A-B" is a triangle; complete as a parallelogram with the side "O-B" the diagonal. Call the opposite corner of the parallelogram "C". By use of the protractor, determine the angle "A-O-C". This angle converted to meridian bearing is the direction the whipstock is set to obtain the result "O-B".

Example: (Fig. 33).

The last single shot reading was 15 deg. .00 min. North 80 deg. East and it is desired to turn the hole the maximum to the right without losing any drift angle.

Using the procedure outlined before from "O" lay off "OA" North 80 deg. East and 15 deg. long using the scale one inch equals four degrees.

About "A" describe circle of 3-deg. radius (the dog-leg of size whipstock being used).

As it is desired to obtain the maximum right hand turn and maintain a 15-deg. drift, describe an arc whose radius is 15 deg. so as to intersect the 3-deg. circle about "A". Call this right hand intersection "B", then "OB" equals 15 deg. and "AB" equals 3 deg. By means of a protractor determine the direction of "OB", which is found to be South 88 deg. East.

Complete the parallelogram "OABC" with OB the diagonal. By use of a protractor determine the angle between OA and OC (96 deg.). Adding to the original course of the hole, the whipstock if set facing South 4 deg. East will give the desired result.

Fig. 34 is an illustration of a set of scales arranged in such a manner that deflecting tool settings can be quickly and easily determined. Referring to the nomenclature of the illustration, scale "A" is a lineal scale progressing from "O" on the left to any convenient value usually 15 inches (1 in. = 1 deg.). This scale is labeled Existing Drift Angle. Scale "B" is identical with the "A" scale but pivital about "O" and labeled New Drift Angle. Scale "C" is a 90 deg. circular segment of radius equal to scales "A" and "B" and is divided into degrees. It is labeled Degrees Turn. The protractor is an independent unit whose straight edge is slidable along the base of the "A" scale and carries in addition to the 180-deg. scale "P" about its arc, a series of concentric semi-circles P of the same scale 1 in. = 1 deg. Scale "P" is labeled "Setting" and scale p "Dog-leg".

In practice to determine the setting of a whipstock and the theoretical results to be obtained, from this chart, the existing drift angle and bearing of the hole being known, the index of the protractor is brought adjacent to the value of the existing drift on scale "A". The "B" scale member is swung around till the figure representing the desired drift angle contracts the arc on scale "P" representing the corrected dog-leg of the whipstock being used. The position of this point on contact on the "P" scale indicates the number of degrees to be added or subtracted (add if turning to right; subtract if turning to left) from the original bearing of the hole to establish the setting azimuth. The intersection of the "B" scale on the "C" scale indicates the number of degrees the hole will be turned from the setting. Fig. 34 illustrates the position of the scales in determining the setting of a whipstock to develop the maximum right turn in a hole of 8-deg. drift angle without lowering this angle.

The index of protractor is brought opposite eight deg. on "A". The "B" scale is moved over the protractor until the 8-deg. mark contacts the arc on scale P representing 2½-deg.

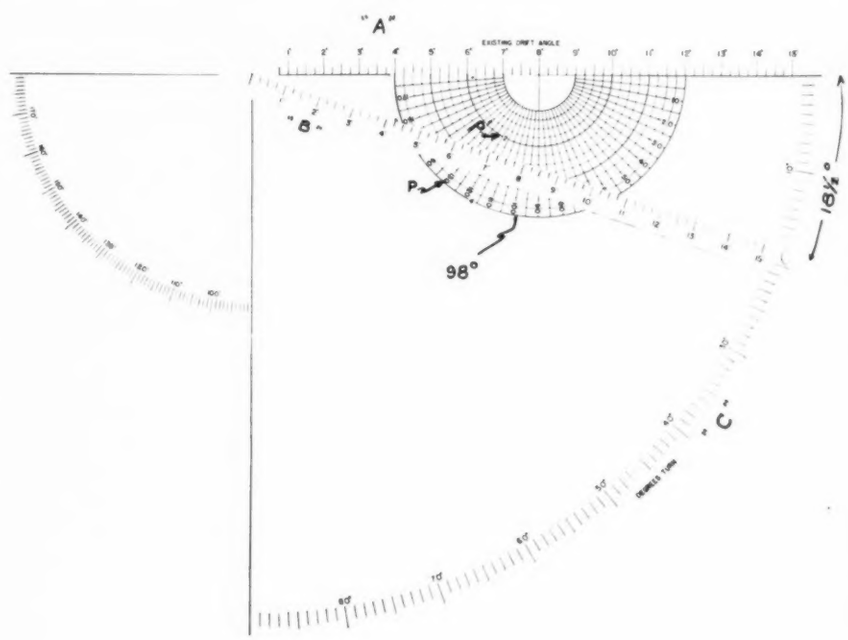


Fig. 34. Chart for quick determination of tool setting.

dog-leg. Reading the position of this contact upon the P scale it is seen that by setting the whipstock 98 deg. to the right of the existing bearing, a resultant turn of 18½ deg. can be expected; this latter determined by the index of scale B upon scale C.

The corrected "dog-leg" mentioned above is the result of a correction that must be made to compensate for the tendency of the pipe to bear upon the inside front of the whipstock ring, thus leaning the top of the whipstock toward the center of the hole. The following table of corrections is based empirically upon the differences in diameters between the whipstock and hole.

Size Whipstock	Dog-Leg	Angle to be subtracted for every inch difference in O.D.
5½ in.	2 deg. 45 min.	0 deg. 30 min.
6½ in.	3 deg. 09 min.	0 deg. 37 min.
7½ in.	3 deg. 26 min.	0 deg. 35 min.
8½ in.	4 deg. 15 min.	0 deg. 35 min.
10 in.	4 deg. 21 min.	0 deg. 33 min.

The angular correction is multiplied by the number of inches difference between the diameter of the whipstock and the diameter of the hole. This figure is subtracted from the indicated dog-leg and the remainder used as the effective dog-leg in calculations of setting.

Having determined the theoretical setting azimuth of the tool a final correction is made for roll-off or the tendency of the bit to crawl to the right. The magnitude of the correction depends upon the type tool being used; condition of tool and bit, formation being drilled, condition of the hole and finally, the engineer's judgment. The correction will vary from nothing to ten deg. on whipstock tools and up to 65 deg. on knuckle-joint types, is minus on left-turn setting, plus on right-turn.

Not always do the actual results from a whipstock setting agree with the indicated theoretical. This can readily be imagined when it is realized that the theoretical is based on the ideal, while in practice the conditions in a hole under which a whipstock is set are anything but ideal and never the same.

An analysis of hundreds of whipstock settings under all conditions shows that the average difference between the actual and theoretical results is only 8.6 deg. in direction. This average difference includes many settings under the worst possible conditions where results fell far under expectations.

That a deflecting tool can be controlled within these small limits of error is indeed a remarkable achievement and deserving of more credit than has been given.

How Many Gallons in Any Vertical Cylindrical Tank?

By W. F. SCHAPHORST

THE accompanying chart answers the above question for any height from two in. to 600 in. (50 ft.), and for any diameter from three in. to 1000 in. (83 1/3 ft.).

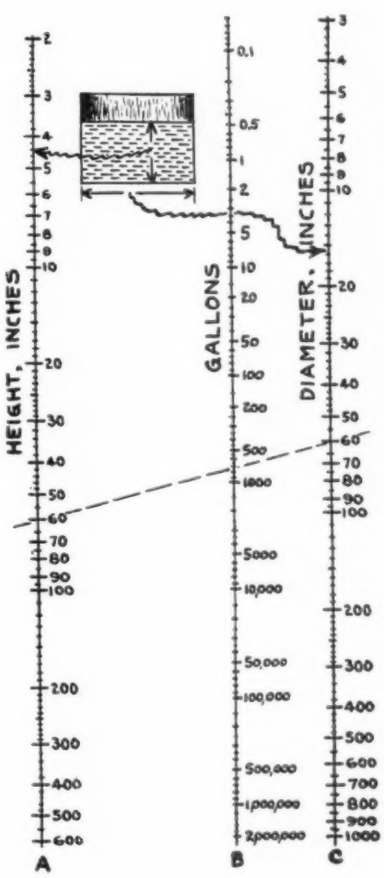
To use the chart, simply run a straight line across connecting the height of the tank (column A) with its diameter (column C) and the intersection with the middle column (column B) gives the gallons instantly.

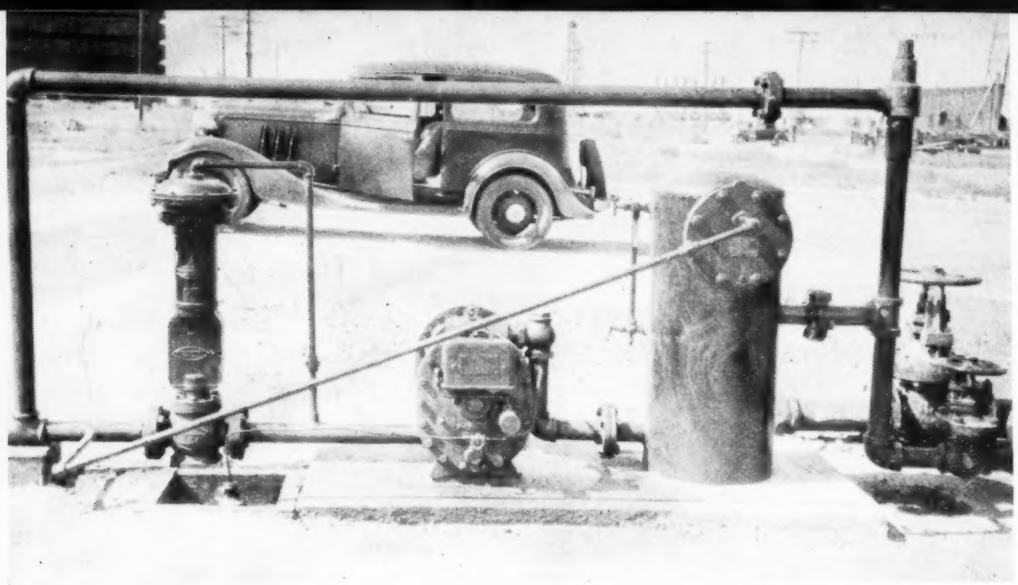
For example, if we have a tank 60 in. in height and 60 in. in diameter, what is its capacity? The dotted line drawn across the chart shows how it is done. Connect the 60-in. column, A, with the 60-in. column, C, and the intersection with column B, gives the answer as — about 730 gallons. Figure it out with a lead pencil and it will be found that the correct answer is 732 gal., which shows that the chart gives results that are remarkably close.

In case it is desired to know the amount of liquid in a given tank at a given time, column A represents the depth of the liquid in inches and column C the diameter in inches, as before. The figures in column B then represent the number of gallons in the tank.

The chart may also be used backwards for determining the height to which a given tank should be built and the diameter it should be given for a capacity of any number of gallons. It may also be used for determining the height to which the tank must be built where the capacity and diameter are both fixed. In other words, where any two of the factors are known the third is easily found by means of this chart.

As will be noted, the maximum capacity of the chart, column B, is 2,000,000 gallons.





A typical installation of a Bassler displacement meter measuring oil from an oil and gas separator. Upstream from the meter is the gas eliminator and downstream a pressure regulator. The gas taken off at the eliminator is put back into the line beyond the regulator

« « « Metering Production F

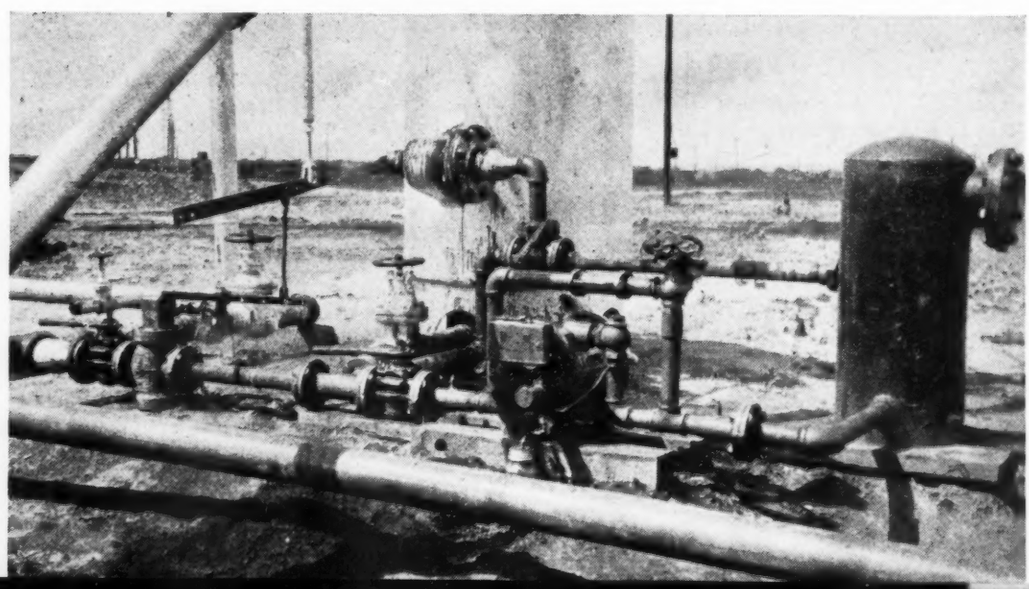
By WALLACE A. SAWDON, Petroleum Engineer, Los Angeles

THE measurement of crude oil by means of meters has been a practice with some of the operators in several California fields for a number of years. Such metering has been confined mainly to the production from individual wells; but the accuracy obtained by proper meter installations and the economy provided by them under certain conditions has indicated that their adaptation to field conditions is becoming more generally recognized. An increased interest has been displayed during the past year in meter installations; and while most of these have been used for measurement of production from individual wells, the high degree of accuracy reached should eventually widen their scope of application.

The results obtained with both orifice and current meters in measuring the production from wells flowing under pressure in Kettleman Hills have demonstrated the adaptability of these types under the conditions there encountered. There have been, however, installations of displacement and gravimetric meters to a wide extent in other fields throughout the state. These meters have operated with such a high degree of accuracy under such a variety of conditions that they not only have established themselves as a reliable means of measuring crude oil production but, conversely, have also by their agreement with gauges made in carefully strapped tanks demonstrated the accuracy of such gauging.

In California, it is required that a report of individual well production be made monthly. While this report may be estimated from a measurement of flow taken for only a number of days during the month, some means of getting the measurement must be provided. A gauge tank can, of course, be used for a number of wells. But so can one meter installation if it is not desirable to meter the production of each well continuously. In states where individual well production reports are not required, considerable error is often made in estimating the value of certain wells when their production is not measured. Expensive tankage for gauging only is not always

Here is shown a flange-to-flange hook-up of a Bassler displacement meter mounted on skids so that it can be removed and replaced easily by a smaller size as the production declines. Weed Patch area near Bakersfield



warranted; but with meters available for measuring individual well production, the value of a well based on its actual production can easily be obtained.

One of the chief reasons for using a meter to measure production for individual wells is an economic factor always worthy of consideration—the saving in tankage. Moreover, the space for tankage is not always available, as in the case of the line of wells between the railway and the ocean at Huntington Beach. Displacement meters have been in use for measuring the oil from these wells for several years. With town-lot drilling, too, space is not often available for tankage necessary for gauging individual well production.

There are also other advantages in metering production. The fire hazard is naturally reduced when gauge tanks are eliminated. This is worthy of especial consideration in congested areas where space for gauge tanks is so seldom available anyway; also, oil

Need for greater accuracy and economy in measuring individual well production has led California operators to use of meters. Various types have been adopted to meet different field conditions

ing wells. The condition of flow, the pressure, and the presence of gas in different amounts will influence the installation, which naturally cannot be identical for all wells. It is placed in the line on the down-stream side of the trap (when used) as indicated in the photograph of a typical installation.

With the displacement meter, the flow line remains a closed system from the intake, through the meter and to the discharge, whether the production be under pressure or flowing by gravity. This type meter, therefore, can readily be placed at the point of production and the oil piped any distance to storage, which can be centralized at any convenient point. This is particularly advantageous in necessitating only one gathering line from a number of wells and will save considerable piping expense, even when the storage is on the lease.

The meter is not affected by the pressure applied or by changes in rate of flow. Different size meters are used for different rates of production.

n From Individual Wells » » »

meters are automatic in operation. They, therefore, eliminate the personal element in gauging and in computation from tank tables.

There is a growing demand for a permanent and accurate record of production. With the counter on a meter properly sealed, the number of barrels (or other units for which it is calibrated) that have passed through it is always available for inspection. Contingencies that are caused by unexpected pipe line demands and frequently result in errors, have no influence on meter readings.

Most of the oil meters now in use take samples of the oil as it passes through the meter; and under many conditions, such samples are more representative than those that can be taken from a tank with a thief. In the case of some of the oil in the San Joaquin Valley, a truly representative sample is almost impossible to obtain from tanks or sumps into which it is run and several operators have asserted that samples taken by meters are of sufficient value in themselves to warrant the use of the meter.

The samples taken by some meters are continuous; and it makes no difference what changes in the character of the fluid may be, the samples are definite portions of the fluid that passes through the meter. If a well makes a flow of water and then a flow of clean oil, an accurate proportion of water and oil is contained in the sample. The sample gives a true picture of the content of the fluid over a period of time and eliminates errors caused by a disproportionate sample that may be taken at a time when the flow is preponderantly water or oil.

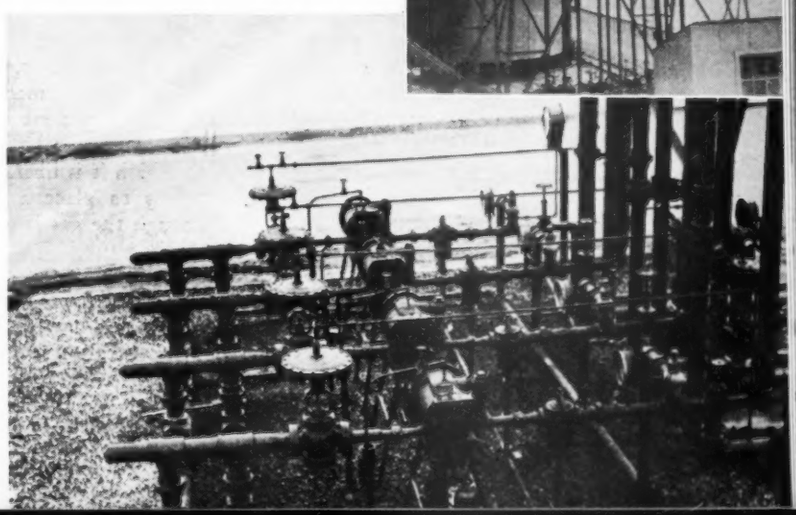
In taking continuous samples from light oil by meters, it has been found that precautions must be taken to prevent loss of the lighter fractions through evaporation. With such oil, representative samples are usually easy to obtain from the storage tanks; but when samples are desired of the oil as it passes through the meter, the jar in which the sample is collected can be protected from sun and weather and made fully as representative as that taken from the tanks.

Displacement Meter

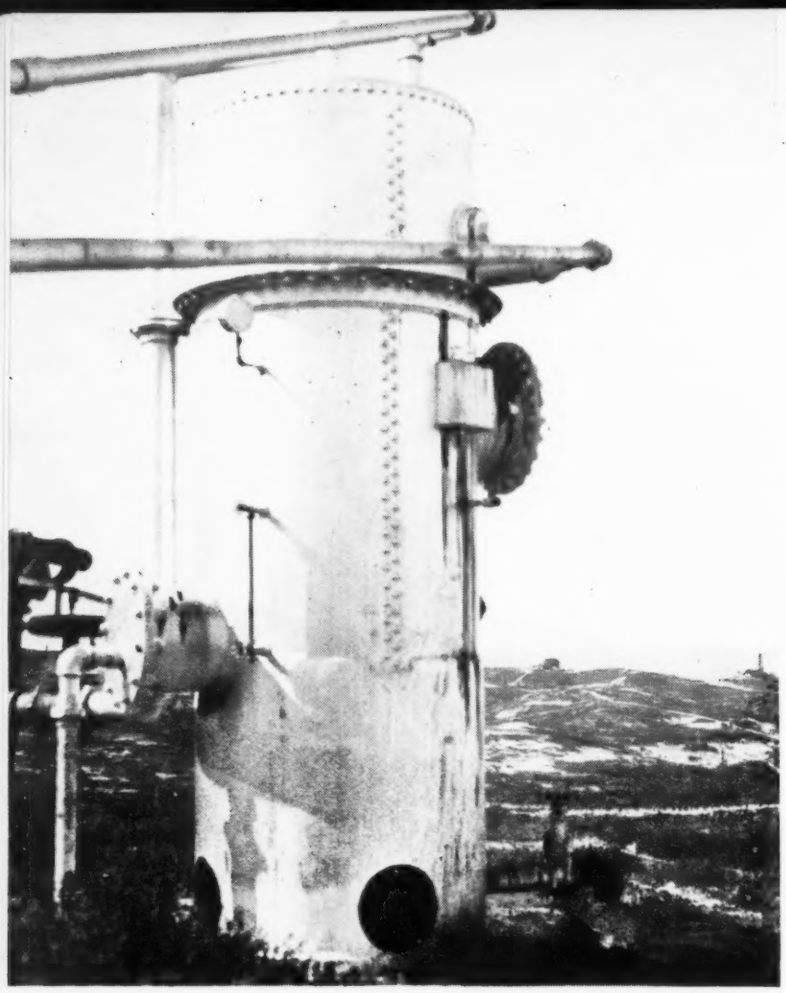
This type meter, as shown in the illustrations, has been designed to handle production from either pumping or flow-

During the past year, a flange-to-flange hook-up has been worked out with the meter mounted on skids to provide easy replacement by a smaller capacity meter as the well production declines. This relieves the larger meter for new wells and keeps the flow within the capacity of all the meters in service.

Flow through the displacement meter may be caused by considerable line pressure or may be by gravity provided by a small head. In many installations, this head is only a few feet with the flow line from the gas trap just above the meter and the differential between the intake end and the discharge into lease storage



This installation of Bassler displacement meters measures individual well production from four wells between the railway and the ocean at Huntington Beach. The traps of three of the wells are shown in their elevated position in the upper view



A special installation of an Oil Weigh gravimetric meter mounted within a gas trap, Buena Vista Hills

frequently as small as five feet. Control of flow through the meter is often regulated by a valve on the discharge side actuated by a lever connnected with the liquid-level control valve of the separator.

The displacement meter now in general use in California is of the single-cylinder, positive piston displacement type. The piston moves back and forth in the cylinder, which constitutes the measuring chamber. The operation is controlled by two main valves, one at each end, and a pilot piston valve to carry the main valves past dead center. As the piston moves from one end of the meter to the other it forces out the oil that has completely filled the cylinder behind it on its previous stroke in the opposite direction. At the same time it causes a twisted square rod passing through its center to revolve and actuate a counter. This counter indicates the volume of oil passed in gallons, barrels, liters, or whatever unit is desired. On reaching the end of its stroke, the valve that was open, closes, and the valve that was closed, opens, to permit entry of the oil on the other side of the piston and force it in the opposite direction.

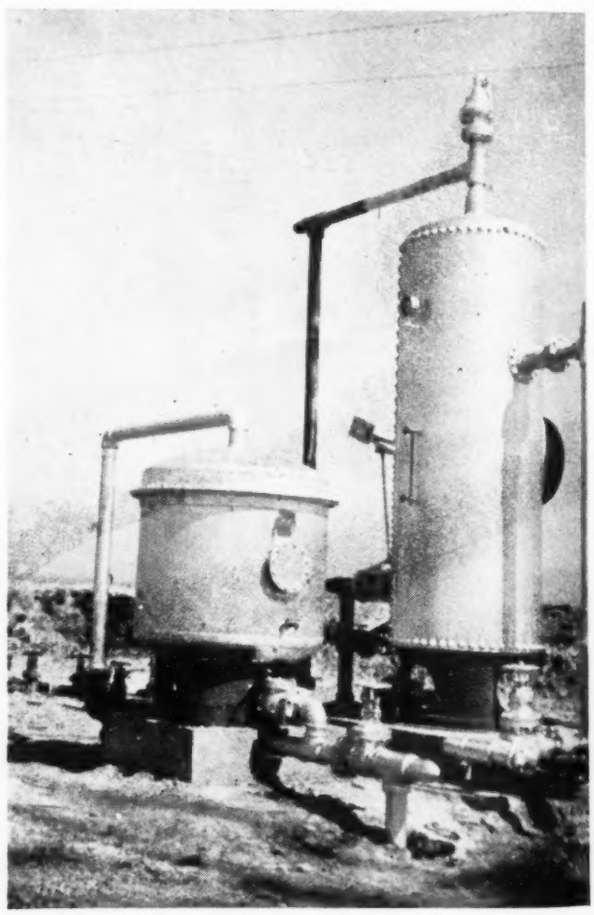
By careful calibration of the cylinder, the amount of oil displaced at each stroke is accurately measured. Results obtained have shown that it is possible to keep all error within less than one percent. Since the accuracy has generally been determined by comparison with tank gauging, there is a possibility that any error may be in the gauging rather than in the metering. Under average conditions with a properly installed meter, the error of measurement is probably less than that attending manual gauging, which has the personal element always present and never considered.

The presence of gas and the degree with which it is liberated must be provided for. The usual practice is to place a gas eliminator up-stream from the meter. Although the gas is supposed to be taken off at the trap, complete separation is seldom possible. Unusual operating conditions must, of course, be given due attention and any gas that might influence the measurement must be taken care of. The gas from the eliminator is put back into the line down-stream from the meter and beyond any back-pressure regulation that may be used.

It has been found in most cases where the meter is operating under pressure that a back pressure should be maintained. This is usually done by means of a pressure regulator. In all cases, a sediment trap must be placed ahead of the meter to remove any foreign matter from the oil.

In order to eliminate the necessity for correcting for temperature, the displacement meter can be equipped with a thermostatic control. This automatic device is made an integral part of the meter and consists of a small container filled with the oil being metered. As the temperature rises above 60 deg. fahr., the oil in the container expands to operate a mechanism on the piston. This increases the size of the measuring chamber to such an amount that the volume displaced at each stroke will be the exact amount of oil when reduced to 60 deg. fahr. that is indicated by the counter. When the temperature of the oil being measured falls below 60 deg. fahr., the reverse action takes place.

A meter equipped with the thermostatic control will thus give the volume of oil passed through it corrected to 60 deg. fahr. Any other temperature base desired can be used. Though many of the companies use the meter with-



Pressure type Oil Weigh gravimetric meter installed with gas trap. Sufficient back pressure is maintained on the trap and meter to force the oil from the meter to the lease tank farm

The semi-enclosed type of Oil Weigh gravimetric meter employed on wells that blow gas in insufficient volume to warrant the installation of a gas trap. Meter mounted over a sump

out the thermostatic control and correct the volume indicated for temperature, the automatic feature will probably come into more general use.

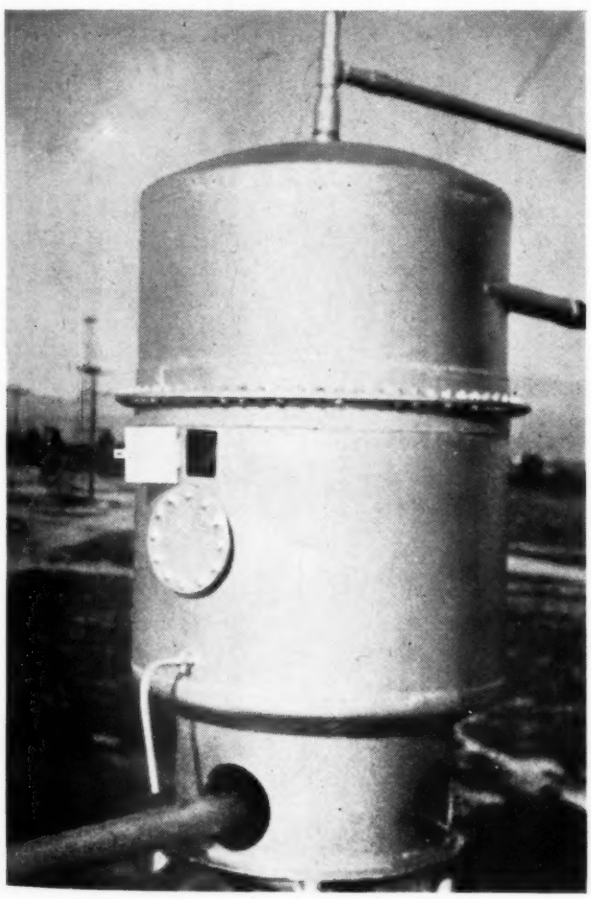
Where production remains at a fairly constant temperature, one correction factor can be applied to the meter reading for a considerable period of time. In one of the recent fields in California, however, shipping temperatures have been noted to range from 80 deg. fahr. to 135 deg. fahr. The automatic temperature control will eliminate a considerable amount of error in such cases and will also save computation that must be added to the inconvenience of taking temperatures.

Proration has often caused temperature fluctuations that are difficult to handle without thermostatic control. Wells are frequently opened up or pinched in to make up or cut down quotas; and the temperature of the oil under different rates of flow has often been noted to vary to a considerable extent.

The wear on parts of the displacement meter has been found to be very slight in the average installation for measuring crude oil. Lubrication such as is often necessary when using it for measuring wild gasoline is not necessary. Sand and foreign matter can be prevented from entering the meter and when excessive sand is encountered extra precautions should be taken to keep it out. One company with a great number of meter installations in several Los Angeles Basin fields has found that maintenance work can be handled by one service man for all the meters in this area.

Gravimetric Meter

The gravimetric type of meter operates on the principle that the unit weight of a given gravity of oil remains constant under all conditions. If the temperature of the oil is above or below 60 deg. fahr., the volume is increased or decreased from the volume at that base; also, if gas is occluded with the oil, the volume is increased. Yet the weight remains the same and for every given unit of weight there is just so much oil at 60 deg. fahr. The meter registers the oil in these weight units and to compute the quantity of oil at 60 deg. fahr., correction factors for clean oil gravity and water content need only be applied. A sample given by the meter is used to determine this gravity and water content.

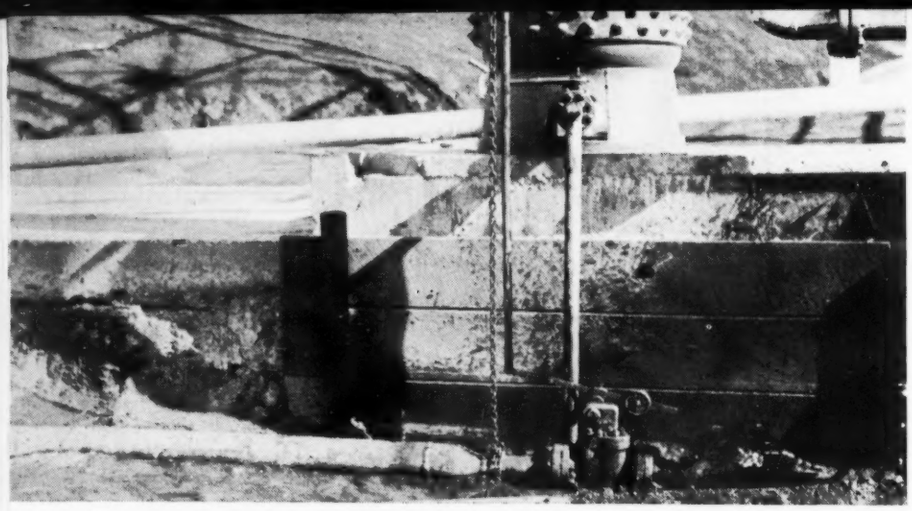


A gas-dome type Oil Weigh gravimetric meter without gas trap installed as a low-pressure unit in two-stage gas recovery system

Meters of this type widely used in the San Joaquin Valley consist of two V-shaped compartments, welded back to back and mounted on an axis. Oil discharges from the lead line into one of these compartments until the weight of the fluid causes it to revolve about the axis. This makes the full compartment discharge and places the empty one into position to receive the flow. When this reaches the predetermined weight the action is reversed with the second compartment discharging and the first brought back to position for filling.

Two kinds of gravimetric meters are being used; the open type and the closed type. The open type is applicable for measuring low gravity oils. It is also used where the wells are producing a stable gas foam or emulsion, for very viscous oil, and when quantities of sand accompany the production. A considerable amount of the oil in the area around Taft is run into sumps and is thus easily metered by the open type gravimetric meter, which discharges directly into the sump. When the run is into storage tanks, the meter is placed above the tank.

It has been found that higher gravity oils can better be measured with the closed type to prevent evaporation loss. The discharge from this type may be by gravity at or near atmospheric pressure. The location in such cases is usually at the top of the storage tank. The closed type, however, can be used with a pressure discharge from the meter into the oil line. When so



Velocity type current meter measuring oil from trap at Kettleman Hills

The installation of the oil meter within a gas trap has been developed by one of the larger producing companies and at the present time 20 such installations are in service. This is a special type of installation and it has to be designed to meet the conditions encountered and the requirements of the operation. One particular design at Buena Vista Hills is shown in an accompanying illustration.

used, the installation is made on the discharge side of the gas trap with sufficient pressure maintained on the trap to overcome the maximum oil line pressure and keep the meter from flooding with oil.

During the past year some interesting developments have been made in the application of the closed type gravimetric meter. A number of installations have been made in the producing areas around Taft and Bakersfield in which the meter has been made an integral part of the gas separation and recovery system to combine the oil measurement with one stage of separation. In some cases the meter housing is provided with a gas dome and acts as the low pressure unit in two-stage gas recovery. In other special cases, the meter is installed within a separator.

At the present time there are four general types of installation being used for this purpose. In one, the meter is contained in a vapor-tight housing with gas dome and discharge connections for both oil and gas. Operation is at atmospheric pressure with the oil being discharged by gravity and the gas drawn into a vacuum gathering line through a regulator. This installation provides a vapor-tight measuring unit combined with a vapor recovery system.

An application of the meter enclosed in a pressure type housing with gas dome and discharge connections for both oil and gas provides for operation at pressures up to 40 lb. per sq. inch. In this case, the oil and gas are being alternately discharged through a liquid-level control. One control valve is sometimes used for a group of meters. The oil can be discharged into one small vapor-tight receiving tank where vapor for secondary gas separation at atmospheric pressure may be recovered.

A third kind of installation also uses the meter in a pressure type housing with gas dome; but it has a single discharge connection at the bottom for the oil and gas. In this application, the gas is either partially or wholly separated in the dome and the oil is measured through the meter. The oil and gas discharge together into a common gathering system.

On one of the larger leases, this method is used with one meter placed at each well and several meters discharging into a common trunk line that carries the oil and gas to the lease tanks. Here the production goes through a separator where the gas is taken off and the oil run into the tank. In addition to eliminating the well gauge tanks, this system necessitates only a central gas separator and no traps at individual wells; moreover, only one gathering line is used for both the oil and gas.

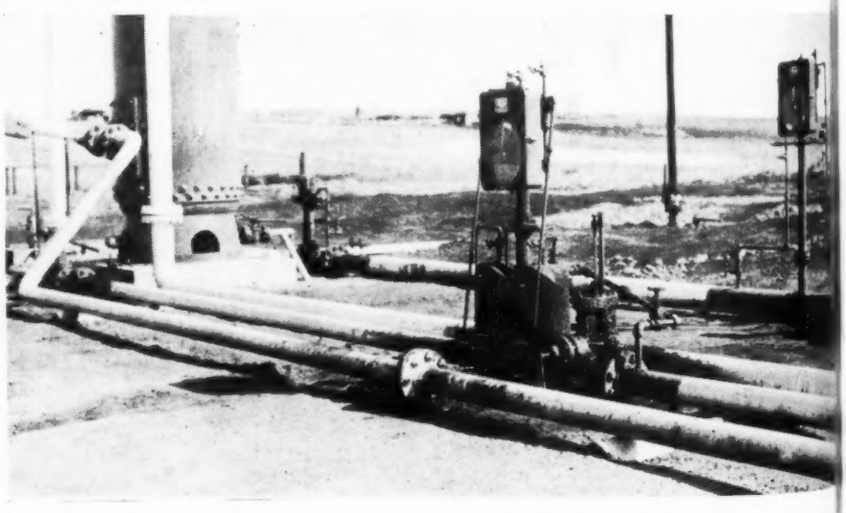
Well Meters In Kettleman Hills

The orifice meter and the velocity type of meter are both being used on the high-pressure wells on the North Dome of Kettleman Hills. These meters are measuring oil that has a high gas content under pressure. Yet, by the application of coefficients derived by empirical means for the specific conditions of operation, they give measurements that check very closely with those made by tank gauging.

Both types are placed on the oil flow line from the separator. Gas, in many instances, is taken off in these separators at a very high pressure and the metering is done at approximately this pressure. In such cases, the oil goes to a second stage separator for further gas recovery after passing through the meter. There is, therefore, a considerable amount of gas with the oil being measured; and this requires the application of coefficients to give the volume of oil at atmospheric pressure.

Various wells are flowing under different pressures and the pressure at which the metering is done varies over a considerable range. The coefficients are therefore derived for specific conditions and applied only to the wells producing under these conditions. Changing conditions are carefully watched and the proper coefficients applied when such changes occur. In some cases the factors are derived by bleeding into a small pressure-tight chamber of known content a sample that is taken at the same pressure and temperature as the flow passing through the meter. The chamber is then opened to atmospheric pressure, which gives a condition identical to the storage tank. The difference in volume is thus determined and with proper temperature correction, the volume of oil at 60 deg. fahr. determined. One company derives its coefficient by check gauging at the tank.

Samples for centrifuge tests and gravity determination are collected as desired and the water content determined for application to the meter readings. Flow through the meter is governed by a regulator valve on the downstream side of the meter that is actuated by a float lever of the separator.



An orifice meter installation for measuring oil from separator and operating at the trap discharge pressure. Note in the right background the familiar orifice meter hook-up for measuring the gas

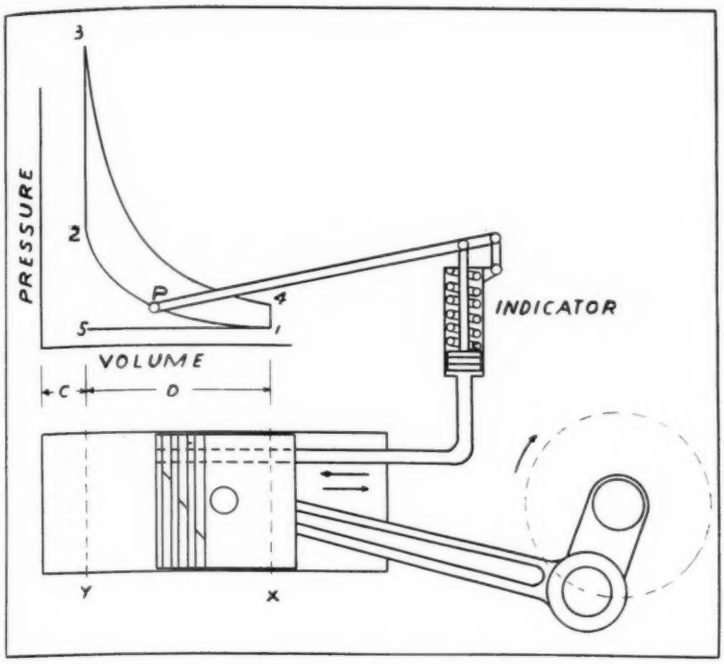


Fig. 1

By
JOSEPH LISTON

Part I

Cycles for the Gas and Gasoline Engines

Fundamentals of the Internal Combustion Engine

THE source of power for almost all the requirements of the oil industry goes back directly or indirectly to the chemical energy in hydrocarbon fuels. These fuels vary over a rather wide range in physical and chemical properties and in adaptability to use as a source of power; however, as the result of a vast amount of research, many of the properties, particularly those bearing upon the value of the hydrocarbon for engine fuel, are now well understood. For instance, refiners can easily predict the starting, vaporlocking, gumming, and knock-resistant properties of a gasoline, and Diesel engineers are rapidly developing specifications for the necessary or desirable properties of fuels for compression ignition engines. Fuel men know that substances such as sulphur are undesirable, and even very small quantities of abrasive material in Diesel fuels have proved to be very detrimental to the life of fuel injection pumps.

The heat energy that any given hydrocarbon possesses is easily determined from the calorimeter and fairly well predicted by empirical formulae. On the whole, our sources of energy are rather definitely understood, and the matter of utilizing them becomes a matter of selecting the most efficient and satisfactory means of converting this energy into useful work.

Disregarding as yet unproved methods, the energy in hydrocarbon fuels may be converted into useful work by:

1. Burning the fuel under a boiler and using the steam to operate an engine or turbine.
2. Carbureting the fuel and burning it in a spark-ignited engine.
3. Injecting the fuel in an atomized form into a cylinder containing highly heated air as in the Diesel.

Each of these means of producing power has proved through wide use to be very successful, and when ordinary performance and economy is all that is wanted, little time need be wasted in selecting the type of prime mover for the job. However, the increasing competition of the present industrial era is more and more focusing attention on that extra economy and performance which, when the margin of gain is narrow, may mean the difference between profit and loss. This attitude is reflected in the power user's increasing interest in improved types of engines, and in knowing more definitely the limits and performance possibilities of the types from which he must choose.

To investigate these limits in the internal combustion engine, it is convenient to resort to some fundamental principles. A brief consideration of the theoretical cycles will be made first.

Internal combustion engines operate upon either the Otto, Diesel, or Mixed cycle. In the Otto cycle, sometimes called the constant volume combustion cycle, the fuel, either gas or a volatile hydrocarbon mixture, such as gasoline, is mixed with the proper amount of air, compressed in the cylinder to a pressure of from 75 to 200 lb. per sq. in., ignited, and, following the pressure rise accompanying burning, is allowed to expand by pushing the piston against the load. The idea of the process is simple, but there are several factors affecting the efficiency with which the process proceeds. To study these factors, a diagram of the process, Fig. 1, is convenient.

In this figure, the motion of the piston is from X to Y and back to X. In moving between these dead-center positions, the piston covers a volume equal to the stroke times the area of the piston. This volume is known as the *displacement*, D. The volume to the left of the piston when at Y is called the *clearance volume*, C. The expression $\frac{C+D}{C}$ is called the *compression ratio*. Essentially, it is the ratio of the initial volume of space for the charge (when the piston is at X) to the volume at the end of compression (when the piston is at Y).

As the piston moves between the dead centers, the pressure in the space to the left of the piston varies as shown on the

pressure-volume diagram above the cylinder, Fig. 1. While the elementary indicator as sketched is not a practical means of measuring the pressure-volume variations in the cylinder, it serves to illustrate the method. In this indicator, Point P moves horizontally with the engine piston and vertically with the pressure variation, the cylinder pressure acting through the connecting tube on the indicator piston and forcing it upward against the spring. The leverage ratio is such that it magnifies the motion of P to facilitate study of the action taking place. In this indicator, the diagram or indicator card drawn by P has a length equal to the stroke of the engine piston, but in the actual indicating of engines, the length of the card is some convenient fraction of the engine stroke.

To analyze the action, assume the engine piston is at point X, a new charge of air and fuel is in the cylinder, and the piston is just starting toward Y. Point P, registering the cylinder pressure, is at 1 on the card. As the piston moves toward Y, the volume to the left of the piston decreases and the pressure increases. When the piston has reached Y, P has traced the line 1-2, and is at point 2. The pressure at 2 is called the *compression pressure*. Obviously, the smaller the volume C in proportion to the displacement D, the higher the compression pressure will be.

In the theoretical Otto cycle being described, the pressure-volume variation during compression in the cylinder may be conveniently expressed by the relation:

$$P_1 V_1^n = P_2 V_2^n$$

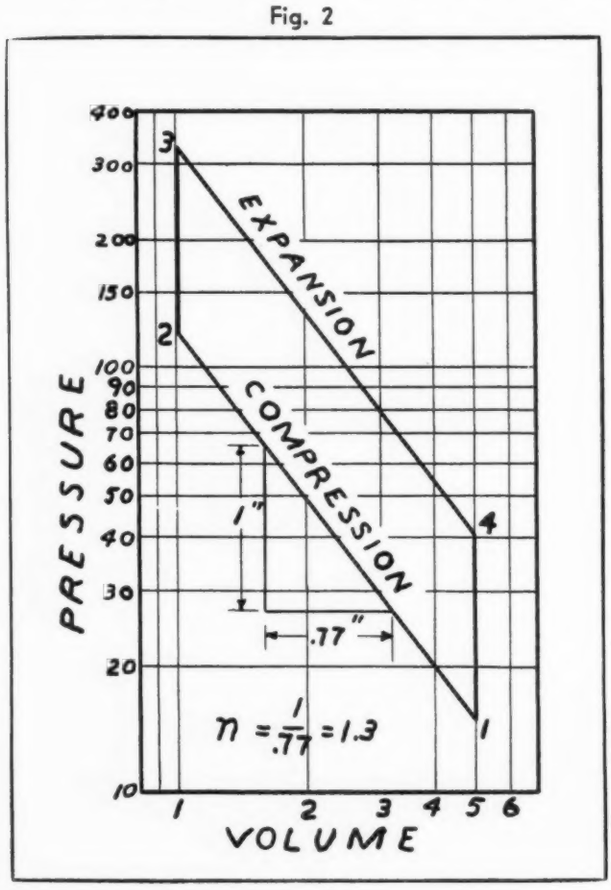
where P_1 and P_2 represent the pressures in the cylinder at 1 and 2 corresponding to piston positions X and Y, respectively.

V_1 = the total cylinder volume to the left of the piston when at X, i.e., C + D.

V_2 = the clearance of volume C, i.e., the volume to the left of the engine piston when at Y.

n is an exponential factor, which, for adiabatic (no heat change) conditions, is equal to about 1.4, but for a closer approach to actual conditions, n has a value between 1.25 and 1.35.

Fig. 2



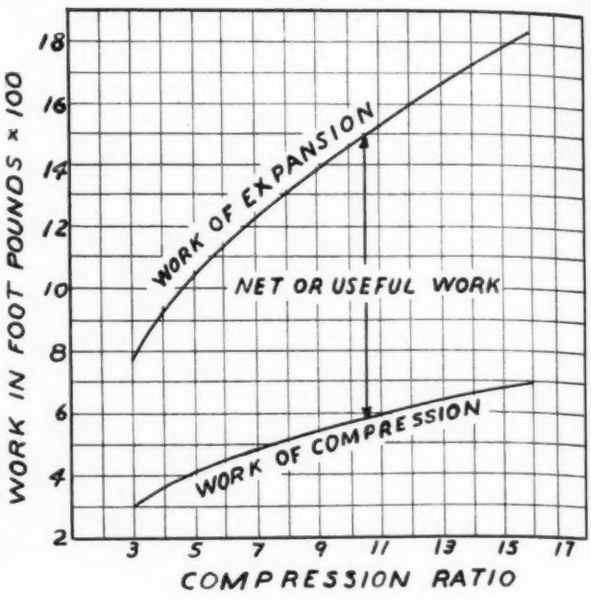


Fig. 3

Since $V_1 = C + D$ and $V_2 = C$, $\frac{V_1}{V_2}$ equals the compression ratio, a quantity that can be determined by measurement of the cylinder dimensions. The determination of n can be made if P_1 and P_2 are known. For instance, if the engine has a compression ratio of five, $P_1 = 15$ lb. per sq. in. abs., and $P_2 = 120$ lb. per sq. in. abs., n may be found as follows:

Rearranging the above expression

$$\frac{P_2}{P_1} = \frac{(V_1)^n}{V_2} = CR^n$$

substituting the assumed values

$$\frac{120}{15} = 5^n$$

taking logarithms

$$\log 8 = n \log 5$$

$$n = \frac{\log 8}{\log 5} = \frac{.904}{.700} = 1.291.$$

In theoretical cycle calculations, n is usually either known or assumed. It has been found from the plotting of compression and expansion lines on logarithmic cross-section paper, Fig. 2, that n usually has a value in the neighborhood of 1.3. If we use this value as representative, the compression pressure may be expressed by:

$$P_2 = P_1 \times CR^{1.3}$$

and for the above data

$$P_2 = 15 \times 5^{1.3} = 121.5 \text{ lb. per sq. in. abs.}$$

At point 2, in the theoretical diagram, Fig. 1, the spark ignites the air-fuel mixture, and the heat energy released in burning causes the pressure to rise to point 3. Then the engine piston moves back to X and the pressure drops from 3 to 4. The expression for this pressure-volume change is:

$$P_3 V_3^n = P_4 V_4^n$$

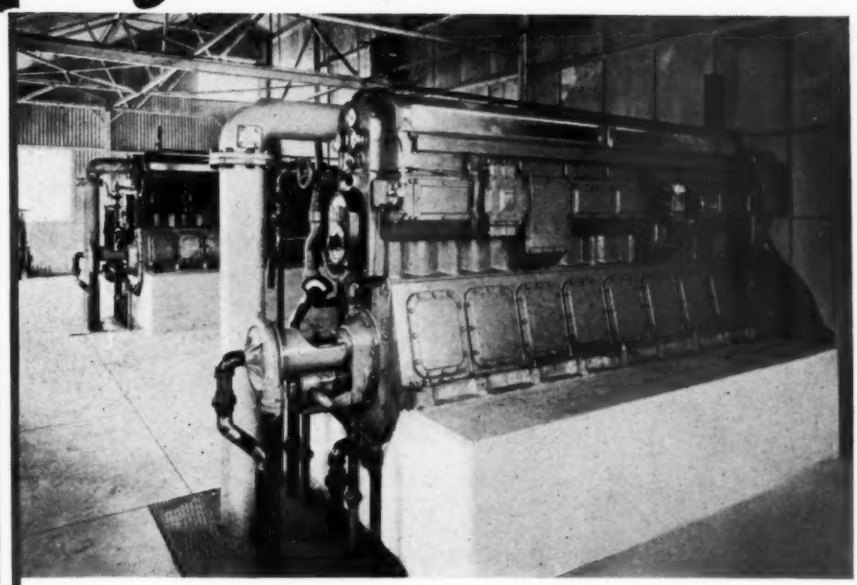
where P_3 and P_4 represent the pressures at points 3 and 4.

$V_3 = V_2$ and $V_4 = V_1$

n has a value near but not necessarily the same as n for the compression line. In preliminary calculations,

OIL *for the lines of Oklahoma*

PUMPED BY MODERN GAS ENGINES



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however, it is usually assumed to have the same value.

From points 4 to 1 the pressure drops due to the escape of heat to the exhaust. In an actual engine, valves or ports for admitting the new charge and exhausting the burned gases are necessary, and these actual processes produce differences between the actual and the theoretical diagrams as will be discussed later.

For the moment, however, it is of interest to see how the work or power output and the efficiency of the theoretical Otto cycle may be improved. This is of interest primarily because the variations in actual engines have been found to parallel closely the variations in the theoretical engine.

Considering first the work that the engine in Fig. 1 can do, it can readily be shown that the work required to compress the charge from 1 to 2 is:

$$W_c = \frac{P_1 V_1 - P_2 V_2}{n - 1} \times \frac{1}{12}$$

where W_c is in ft-lb.

P_1 and P_2 are in lb. per sq. in. abs.

V_1 and V_2 are in cu. in.

n is the same as above

$\frac{1}{12}$ is the factor for converting in-lb. to ft-lb.

As an example of the use of this method of finding the power to compress the charge, suppose the engine in Fig. 1 has a cylinder diameter of five in., a piston stroke of six in., and a compression ratio of 5.5 to 1. The displacement is:

$$D = \frac{\pi}{4} \times 5^2 \times 6 = 117.9 \text{ cu. in.}$$

The clearance volume is found from

$$\frac{C + D}{C} = CR$$

substituting for D and CR

$$\frac{C + 117.9}{C} = 5.5$$

$$C = 26.19 \text{ cu. in.} = V_2$$

$$V_1 = C + D = 117.9 + 26.19 = 143.09 \text{ cu. in.}$$

If we assume n = 1.3 and the pressure at the beginning of compression is atmospheric, i.e., $P_1 = 14.7$ lb. per sq. in. abs., the compression pressure is:

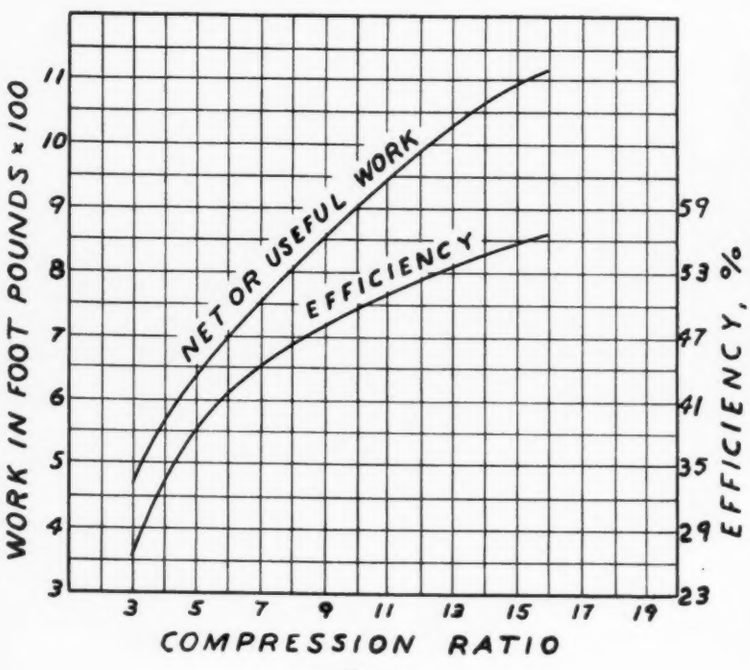


Fig. 4

$P_2 = 14.7 \times 5.5^{1.3} = 14.7 \times 9.2 \doteq 135.2$ lb. per sq. in. abs.

The work of compression may now be found as follows:

$$W_c = \left(\frac{14.7 \times 143.09 - 135.2 \times 26.19}{1.3 - 1} \right) \frac{1}{12}$$

$W_c = -400$ ft-lb.

(The quantity is negative because the work is done by the engine on the gas).

If the engine is turning 800 r.p.m. and a compression stroke occurs each revolution, the power required to compress the charge is:

$$HP_c = \frac{400 \times 800}{33{,}000} = 9.69$$

This power is supplied by the engine in doing work inside the cylinder and is therefore negative work as far as useful power from the engine is concerned. If we increase the compression ratio, the work required to compress the charge will vary as shown in Fig. 3.

The work done by the expansion of the gas from 3 to 4, Fig. 1, is:

$$W_{ex} = \left(\frac{P_3 V_3 - P_4 V_4}{n - 1} \right) \times \frac{1}{12}$$

This expression is similar to the one for compressing the charge, and by applying a similar procedure in calculating, for the above example, assuming $P_4 = 40$ lb. per sq. in. abs.

$W_{ex} \times 1081$ ft-lb.

$HP_{ex} = 26.2$

This is work done by the gas on the engine, and, obviously, the useful work that is developed in the cylinder is the arithmetical difference between the expansion and compression work or horsepower.

$$W_{net} = W_{ex} - W_c$$

For the above example:

$$W_{net} = 1081 - 400 = 681 \text{ ft-lb.}$$

$$HP_{net} = 26.2 - 9.69 = 16.51$$

The variation in the work of compression and expansion with compression ratio, Fig. 3, shows that, although more work is required to compress the charge at higher compression ratios, the work of expansion increases at a faster rate, and, as a result, the useful work that the engine can do is greater at the higher ratios. Fig. 4 shows the variation in net or useful work with compression ratio.

In the above example, for all the compression ratios considered, the same bore and stroke was used; hence, the piston displacement was constant, and, as this governs the quantity of new charge supplied,* we would expect the same available heat energy at each ratio. But the useful work that the engine can do increases with compression ratio, and it is therefore necessary to conclude that the engine is more efficient in converting heat to work at the higher compression ratios. Many tests on actual engines have proved this to be the case.

One of the most convenient expressions for showing the relation between the compression ratio and efficiency for the theoretical Otto cycle is:

$$E = 1 - \frac{1}{CR^{n-1}}$$

where E is the thermal efficiency, the part of the heat supplied that is converted into useful work.

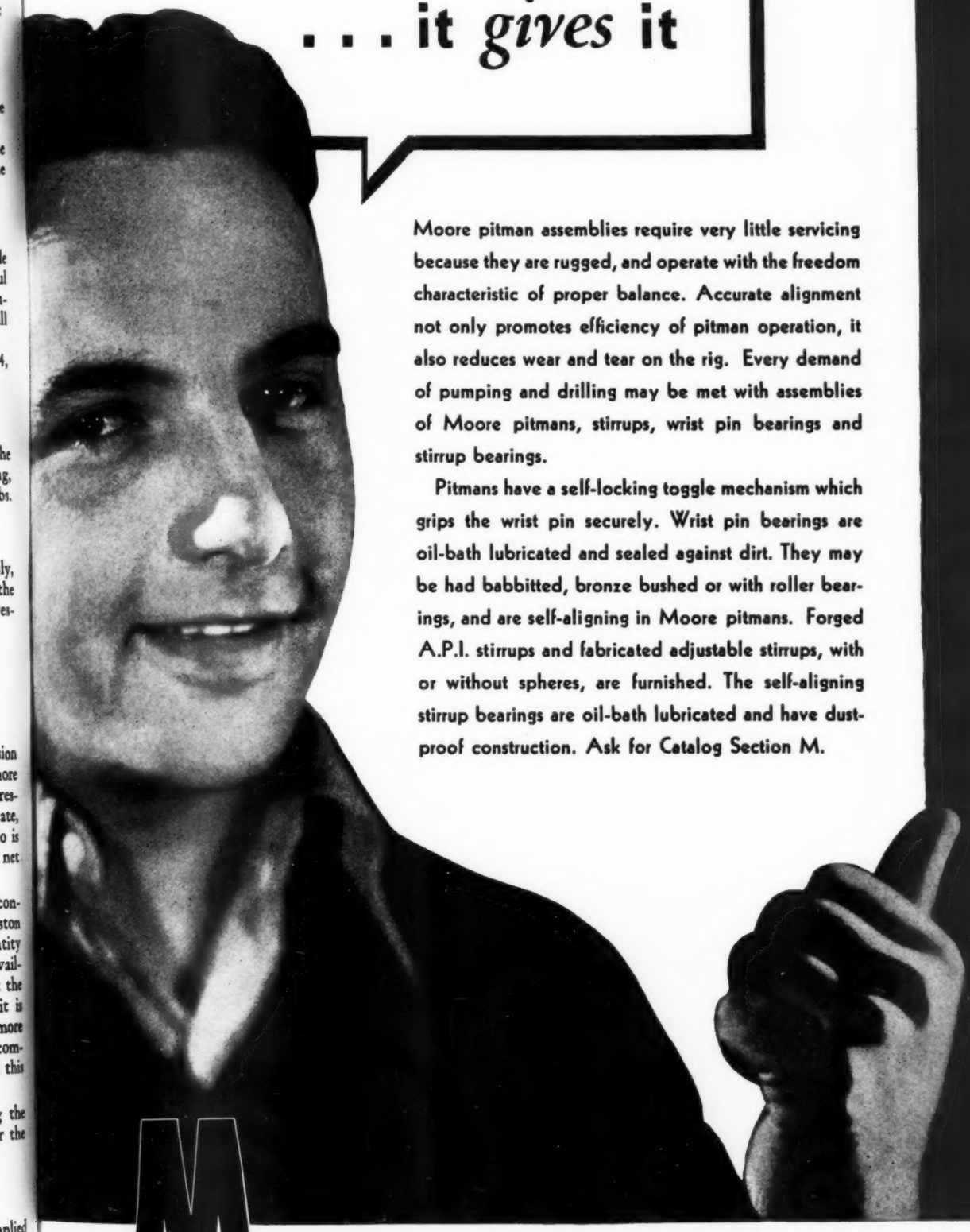
CR is the compression ratio.

n is the same as above.

Values of E for different compression ratios, using n=1.3, are shown in Fig. 4. Actual engine efficiencies have been found by tests to parallel the theoretical efficiencies.

*In the actual engine, certain minor factors tend to vary the charge slightly.

This Pitman Assembly doesn't *take* service ... it *gives* it



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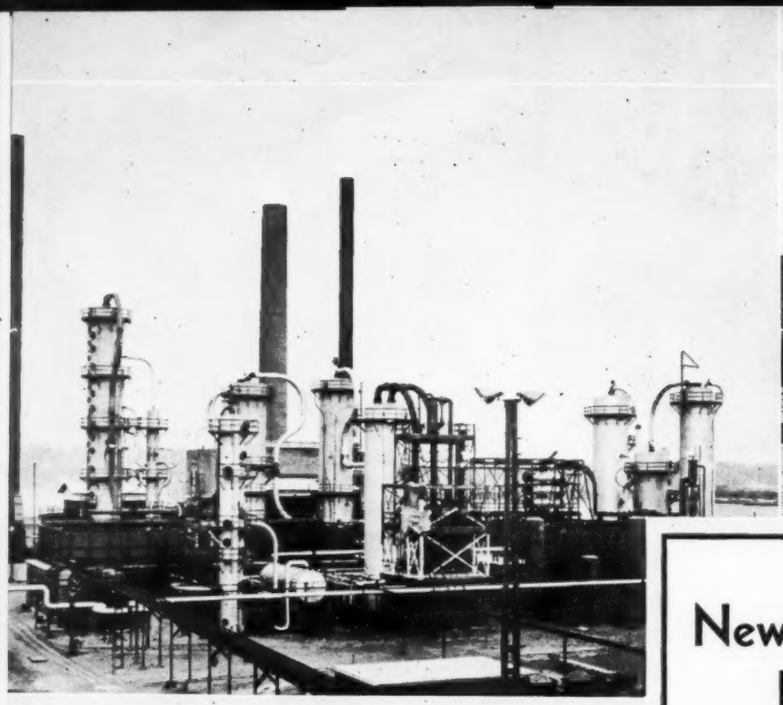
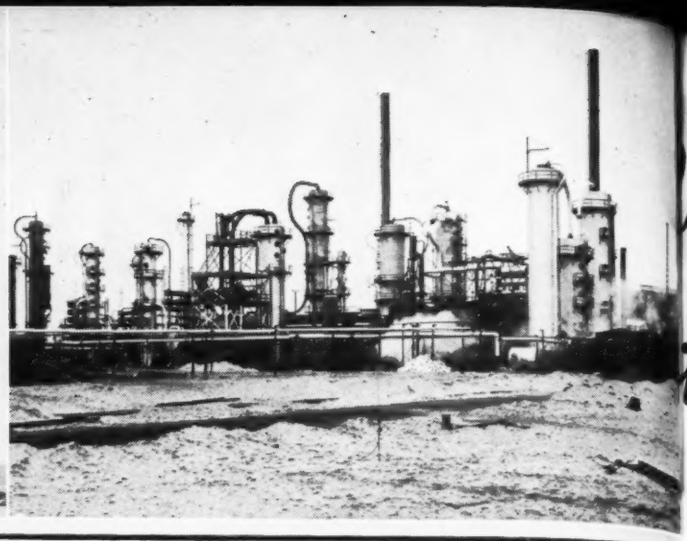




New Refinery at Hamburg, Germany, Running on East Texas and Mid-Continent Crude

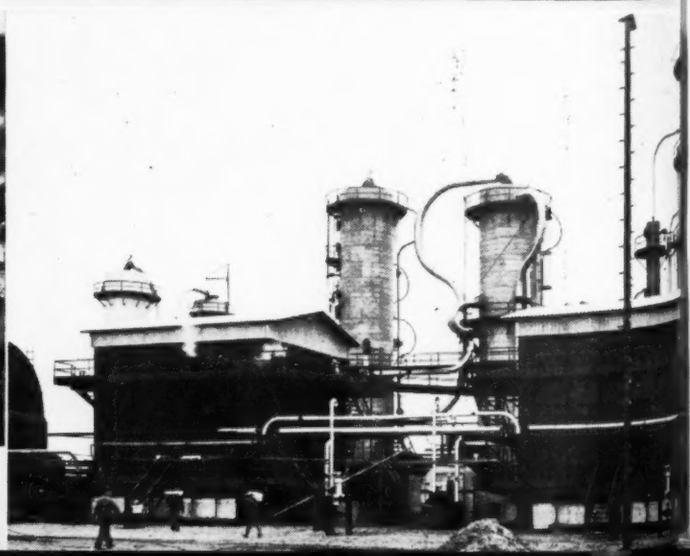
THE illustrations on this page are of the refinery Europaische Tanklager-und Transport—Aktiengesellschaft Zweigniederlassung at Hamburg, Germany.

It is an entirely new plant and was completed and put into operation in April, 1935; it has been running satisfactorily ever since. Crude run to date has been a mixture of East Texas and Mid-Continent oils.

Although constructed for a capacity of 7500 bbl. daily it has been running considerably more than this amount.

Refinery processing equipment consists of a combined skimming and cracking unit with two furnaces in which 2-stage cracking and reforming (when desired) is engaged in; straight run streams of light gasoline, naphtha, kerosene, and light gas oil are produced. Crude oil is debutanized; the raw cracked gasoline vapors are treated continuously in a Lachman vapor-phase treater. The condensed Lachman-treated gasoline is debutanized; the cracking still residuum is flashed to pitch under vacuum and blended back to fuel oil with light recycle stock; gasoline is recovered from fixed gases by absorption. The recovered gasoline, together with the light condensates from the crude and cracked gasoline debutanizer, is stabilized. Straight run, cracked, and stabilized recovered gasolines are sweetened with sodium plumbite separately in three different continuous treaters. Practically all the material entering into the construction of the entire refinery was made in Germany. Crank-and-flywheel, cross-compound, condensing hot oil pumps were supplied by Worthington Pump and Machinery Corporation, as was also the three-stage ejector used on the vacuum tower.

Practically all the instruments were from the U. S. A. Electrical instruments were supplied by Brown; other instruments by Tagliabue, Neilan, and Foxboro.



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Operation of Two-Speed Variable Speed Motor Without Controller

By W. C. LANE

SOMETIMES a knowledge of the inside circuits of the motors in common use in the oil country and a little ingenuity will enable one to avoid an embarrassing delay in starting a pumping well. In preparing a new well in semi-wildcat territory for pumping it was found that a used 15/35-hp. double-speed motor had been provided but for some reason the warehouse man had failed to include a controller in the shipment. Naturally the question arose on whether the motor could be started without a controller and service maintained until one could be procured.

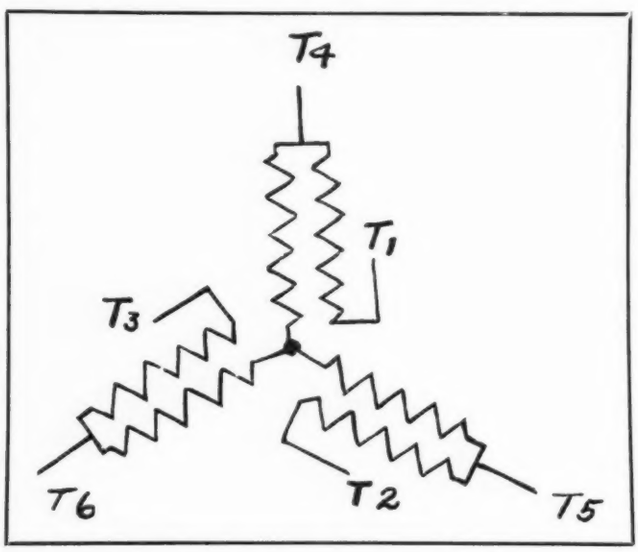


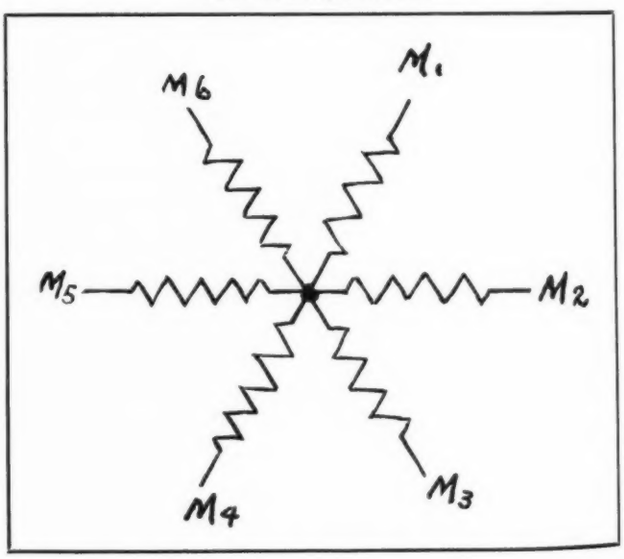
Fig. 1. Conventional stator circuit of 2-speed motor

It is obvious that a slip ring motor when operated on the last point of the controller on the pumping connection is equivalent to a squirrel cage motor. The problem was how to eliminate the pole changer and the controller and get the motor started. Unfortunately the blue print showing the wiring connections that should be found pasted to the inside of the cover of the controller was missing and no other one of the kind was available.

It was recalled that the stator circuits of the double-speed motors put out by the leading electrical manufacturers are very similar and that a uniform system is used for marking the leads; also, that the rotor circuits lack this uniformity and though all types have six slip rings the same connection will not work equally well on all. The stator winding diagram shown in Fig. 1 was reproduced from memory but no one present could recall which of the two common rotor windings is used on the particular motor.

As an experiment, the line wires were connected to the stator leads marked T_1, T_2, T_3 in Fig. 1 and the six slip rings were short-circuited with a piece of bare copper wire. The line switch was fused lightly and the motor disconnected from the load. Upon closing the switch the motor started without difficulty and continued to run at a speed slightly below 600 r.p.m. The same method was then repeated with the load connected and the line switch fused for a normal motor load but before the motor reached its normal speed the fuses burned out. Upon replacing the fuses and turning the well over by hand so that the rods were at the top of the stroke when the switch was closed, the motor started without further difficulty and the well was operated in this manner until a controller was procured; however, it was found that it was always necessary to assist the motor in starting the load in order to avoid burning out the fuses. What may seem strange is that some motors of this type

Fig. 2. Rotor circuit of General Electric and Allis-Chalmers motors



have a dead point when operated without resistance in the rotor circuit. If it happens to stop in a certain position it may have no starting torque.

In general it is not wise to try to operate 2-speed motors in the manner described but it can be done if sufficient care is exercised in getting them started. If one makes sure that the stator connections are correct it is not especially hazardous to experiment with the rotor connections when a motor is disconnected from the load. The twelve leads coming from these motors when regarded as a whole are somewhat confusing but usually each is marked clearly and each marking on a motor put out by a reputable manufacturer has a definite meaning. Such motors are not intended to start without a resistance and when thrown directly across the circuit they have a low starting torque and the rush of current is such that it causes a bad voltage disturbance on the line. Obviously it is necessary to fuse the circuit so heavy that no over-load protection exists.

The diagrammatical sketch given in Fig. 1 applies to the stators of motors made by the Allis-Chalmers, General Electric, and Westinghouse companies and possibly to others. Fig. 2 is the rotor circuit of General Electric and Allis-Chalmers motors while Fig. 3 is that of a Westinghouse rotor. The correct line to stator connection for the low-speed operation of the three companies' motors is to bring the feed wires to T_1, T_2, T_3 and tape up T_4, T_5, and T_6. The six rings or the leads M_1, M_2, M_3, M_4, M_5, M_6 of Fig. 2 are connected

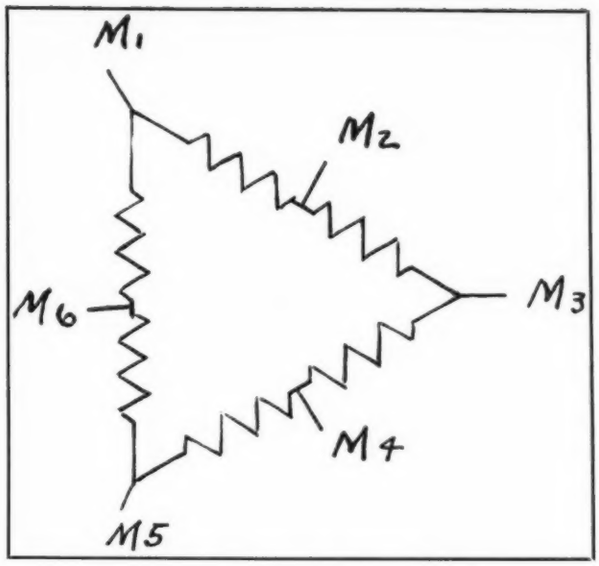


Fig. 3. Rotor circuit of Westinghouse motor

together on General Electric and Allis-Chalmers motors. Leads M_1, M_3, M_5 are connected together; also M_2, M_4, M_6 of Fig. 3 for Westinghouse rotors. It should be noted that the two groups are kept separate.

In such instances as the one cited above it is possible to improvise a starting switch to be placed in the rotor circuit that will eliminate the trouble experienced. Grids from some junked controller may be connected across the posts of two 3-pole single-throw knife switches as shown in Fig. 4 for use with the rotor circuit of Fig. 2 or the single switch shown in Fig. 5 may be used with the rotor circuit of Fig. 3. In each case the rotor leads indicated are connected to the switch instead of being short circuited on one another.

In starting a motor the rotor switch is kept open until after the line switch or magnetic line starter is closed and the motor is approaching normal speed. The rotor switch is then closed thus cutting out the resistance. Of course, the grids chosen will govern the starting torque a certain motor will exert but this method is recommended to be used as an emergency measure only and it is not assumed that there will be a great variety of grids from which to choose. Grids having a resistance such that they will cause a motor to exert its maximum starting torque should be used in case an installation is to be used for any great length of time.

Fig. 4. Grid-switch for use with Fig. 2

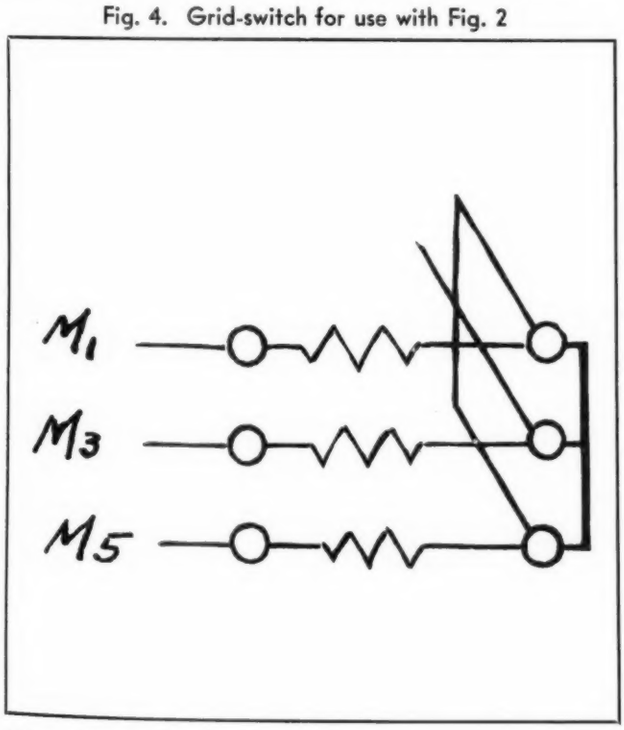
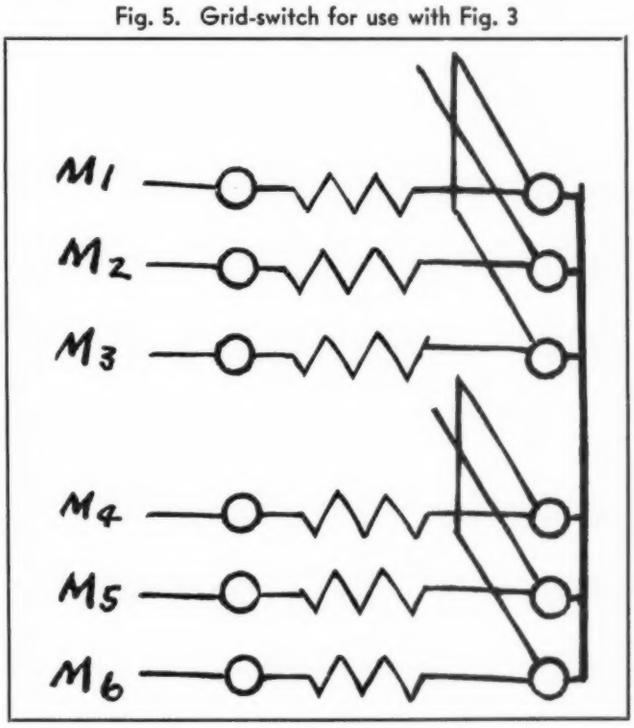


Fig. 5. Grid-switch for use with Fig. 3



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Improving Operation of Diesel Engine

By ELTON STERRETT

Investigation of peculiar knock and excessive ring and piston wear revealed trouble was due to heavy deposit of carbon unbalancing piston

TRANSFERRED from an inoperative station on one of the company's pipelines to a new East Texas main line pumping station, the battery of four-cylinder trunk piston Diesels were accompanied by the man who had been in charge of them at their old location as the new chief engineer.

Following this man, as promotion moved him elsewhere, came a man who likewise had long been associated with that particular lot of prime movers, and who was familiar with every grunt, groan, and squeak of each of them.

Not until this successor to the first chief engineer had been moved on to other fields and a man brought in from outside to run the station was any question raised regarding the cause of the peculiar noise, not exactly a knock, but more of a hollow-sounding "clunk", which seemed to be characteristic of each engine for the first half hour under load after being started up.

The newcomer had met, run, and been much impressed by the make of Diesel used in the station assigned to him, but never before had he noted the unusual noise. Questioned, none of the members of the operating personnel seemed to be able to recall any occasion or change in routine that had brought on the racket, and it was concluded that it had been built up so gradually that the men thrown with the engines daily had failed to note the development of the sound.

A check-back through the station operating log showed but one peculiarity: that there seemed to be excessive ring wear, concentrated almost entirely on the top two rings of each piston. On this point, however, the new chief was as positive as were his associates that the noise was not ring generated.

Pending a shut-down of one of the units to attempt tracing the sound, a number of worn discarded rings were cleaned up and calipered. Instead of exhibiting fairly uniform wear distributed around the outer or wearing surface, almost half of the rings examined were worn to a rough approximation of the old eccentric type of ring, save that the inner contour was still a true circle, while the outer arc, instead of paralleling the other, was from 0.045 to 0.065 in. nearer at some points than at others.

With an engine idle, a piston was pulled, and the rings slipped off and examined. Again marked eccentricity of the two faces was apparent, though not as yet in sufficient amount to cause blow-by serious enough to cause the engine to be withdrawn from service. On examining the piston, carbon was found banked solidly behind the ring through nearly a quarter of the circumference of the ring groove, and was thickest at the spot where ring wear was greatest.

Checking piston diameter after the rings were removed proved that the body was likewise badly worn away over an arc approximating that found affecting the rings, but that this aggravated out-of-round condition did not extend down the walls farther than a line roughly level with the wrist pin.

One piston exhibiting these characteristics so plainly, the other three on the same Diesel were pulled, and in each instance the same deformation was found, approximately of equal depth and extent.

Though there was nothing on the upper surface of the piston to indicate it, the engineer came to the conclusion that the side showing the greatest wear must for some reason be running hotter than the remainder and that this greater heat, causing excessive expansion of the piston, was responsible for the unequal wearing away of the metal.

Checking piston position with reference to the crankshaft, which revolved clockwise, it was noted that the wear was always on the side that took the angular thrust of the connecting rod on the power stroke. With this fact in view, it was considered that the over-carburization beneath the upper two rings was occasioned by the same excessive heat that caused uneven expansion; it also operating to char the oil in the ring groove during what, on the compression stroke, was the idle or low-pressure side, while that portion of the rings would be farthest from "bottoming" in their grooves.

As there was nothing on the outside of the piston to indicate any cause for this excessive heating, a wrist pin was pulled and the rod withdrawn. At first inspection, there seemed to be nothing out of the way inside the piston, a deposit of dense carbon filling in between the reinforcing ribs and making what appeared to be a fairly even surface within.

When, after removing the rod, this same piston was laid on a pair of 2-in. by 4-in. blocks for cleaning, it was noticed that it would not stay in whatever position it was placed but apparently wished to give the lie to the evident wearing away of metal by persisting in trying to roll so as to bring the abraded section downward!

The design of the piston, shown diagrammatically but not in detail of construction other than in the salient point, provided a cover "C" over the upper cap of the wrist pin bearing on the rod, this cap rocking through a slight arc and being hemmed in closely within the limits of its travel by a shoulder or baffle cast within the piston at "I". With the rod and cover removed, and lights at both wrist pin holes, a bank of solid carbon, indicated at "B", was found, but *on one side of the piston only*.

This bank of carbon was carefully chiseled out, and kept apart for weighing. On dividing the head space into halves on a line parallel to the wrist pin, it was found that the excess of carbon on the left side—in the sketch — averaged the startling figures of six lb. two oz. per piston. This unbalanced weight was sufficient to rock the piston against the cylinder wall at the instant of explosion and cause the unusual noise, which, after sufficient time in operation, was eliminated by the swelling of the piston under thermal expansion until it filled the space initially allowing the play. Having determined that this mass of carbon was responsible for the knock, it was necessary to trace the cause of the uneven deposit. By referring again to the sketch, the theory — undoubtedly the correct one — developed by the chief engineer is readily understood. When the connecting rod "R" is at its greatest angularity with respect to the piston—at the instant the center line of the rod is tangent to the crank pin circle "T" — the cover "C" is nearest to contact with the baffle "I" at one side, but at the other leaves a gap "G", which, disregarding any carbon formed there, measures 1.625 inch.

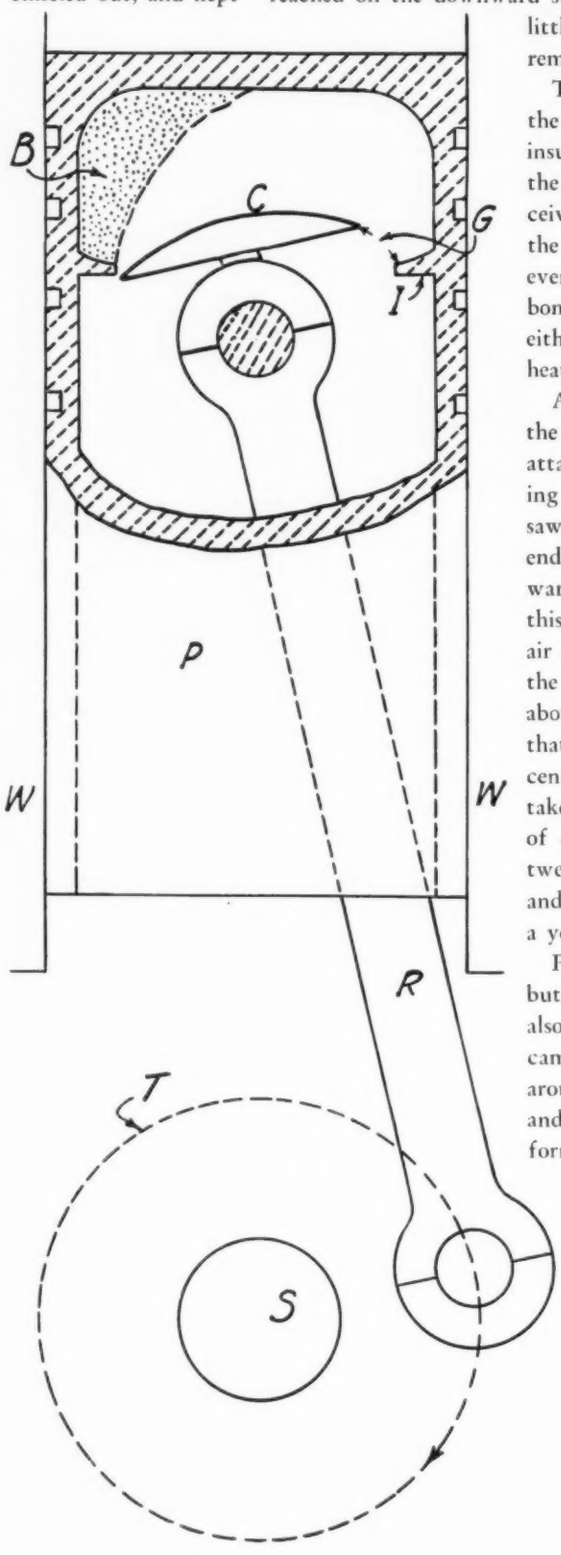
As the piston is moving rapidly downward when this set-up is reached, there is a marked increase of pressure within its walls, caused by the inertia of the air in the crankcase as the piston shell moves down over it. This compression tends to force a stream of air—heavily laden with the oil mist pervading the entire engine base — through the gap "G" and into the space under the head of the piston. Still moving rapidly, this oil-laden air whirls around and over the cover "C" and eddies into the space at the side "B" where, due to the practical closure of the gap between cover and baffle by the angle of the rod, there is little chance of pressure increase from piston motion.

Under the compression thus set up, a portion of the oil borne by the air is squeezed out and deposited on the upper section of the piston to form the beginning of what eventually became a formidable bank at "B". On the upstroke, when the swing of the crank pin has brought the cover over so as to open the gap on the side "B" there is only a slight decrease in pressure, in no way approaching in intensity the value reached on the downward stroke, and consequently there is little scouring effect of the air to remove the oil film just deposited.

This film of oil, carbonizing under the heat of the piston head, tends to insulate that spot still further from the cooling it might otherwise receive from the crankcase air, and the action continues in greater and even greater amplitude as the carbon deposit builds up and prevents either radiation or conduction of heat from the spot blanketed.

Almost complete elimination of the troublesome carbon deposit was attained by taking out the connecting rod cap covers and with a hacksaw removing two inches from the end forming the seal on the downward stroke of the piston. When this was done, it was found that the air compressed within the piston on the downstroke entered the space above the cover in two streams and that their eddying, instead of concentrating on one side, must now take place centrally; the formation of carbon now being uniform between the ribs of the piston head, and so slight as to be negligible after a year's operation.

Following this apparently minor, but necessary, change, it was found also that ring and piston wear became much better distributed around their entire circumference, and was greatly reduced from that formerly experienced.



Sketch showing formation of carbon deposit that caused trouble.

P—Piston
W—Cylinder wall
R—Connecting rod
T—Crank pin travel
I—Baffle ring
C—Cover
G—Compression gap
B—Deposit of carbon
S—Engine shaft

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Acid Treating Lubricating Oils to Improve Viscosity Index

By
GEORGE M. WOODS

THE main difference between Pennsylvania lubricating oils and Mid-Continent lubricating oils is that the former have a better viscosity-temperature relationship than the latter. The measure of this viscosity-temperature relationship is called viscosity index. Pennsylvania oils have been assigned a viscosity index of 100, while Coastal oils, which have a very poor viscosity-temperature relationship, have been assigned a value of 0 viscosity index. One of the most important reasons why Mid-Continent lubricating oils are at present being solvent treated is that this method of refining raises the viscosity index of a Mid-Continent oil to around 100.

The demand for motor oils of 100-viscosity index has driven most of the large refiners to install solvent-treating equipment. Some refiners, especially the smaller ones, have not installed solvent-treating plants for refining of their lubricating oils, and these plants are finding it increasingly more difficult to dispose of their products. Some refiners are probably intentionally holding off installing a solvent plant until they find out if solvent-treated oils will really "take with the public," and also to let the industry have time to establish thoroughly the solvent-treating principle and define the best solvent and best method to use it.

From the preceding discussion it is apparent that the lubricating oil refiners of Mid-Continent grade oil that have not installed solvent-treating plants are faced with almost ruinous competition. For this reason, the possibility of producing a 100-viscosity index lubricating oil from Mid-Continent base stocks by acid treating was undertaken. If a 100-viscosity index motor oil could be produced by using regular plant equipment those refiners that have not installed solvent-treating plants would at least have a "breathing spell" until they could install solvent plants, and in this manner meet competition and hold their business.

With the above in mind, samples of three grades of dewaxed Mid-Continent lubricating stocks were obtained. These stocks were produced from typical Mid-Continent crudes, and were dewaxed in regular plant equipment. Two of the samples were overhead stocks, while the third was a residuum. These stocks had received no treatment other than dewaxing, before being received. Inspection data on the three stocks follow:

Stock	*A*	*B*	*C*
Type	*Overhead*	*Overhead*	*Residuum*
Gravity, deg. A.P.I.	26.8	23.1	21.4
Flash, deg. fahr.	450	515	550
Fire, deg. fahr.	530	625	645
Viscosity at 100 deg. fahr.	471	1590	4600
Viscosity at 210 deg. fahr.	58.1	98.7	197.1
Viscosity Index	76	70	84
Color, Tag.-Rob.	Dark	Dark	Dark
Carbon, percent	0.51	1.45	5.60
Neutralization Value	.05	.05	.05
Pour Point, deg. fahr.	0	5	10

Each of the preceding stocks was given an acid treat of 75 lb. per bbl. of 98 percent sulphuric acid in an open top laboratory agitator. Air agitation was used during the treating. After the acid had been applied and a good "break" obtained, the air agitation was discontinued and the oil-acid mixture allowed to settle for 24 hours. The acid oil was separated from the sludge and measured. The treating losses were calculated to be 20.4, 31.5, and 48.0 percent on the stocks A, B, and C, respectively. The acid oils A, B, and C were then contacted with Filtrol clay under the following conditions:

Stock	*A*	*B*	*C*
Filtrol Clay, lb. per gal of oil	0.5	0.6	1.0
Contacting Temperature, deg. fahr.	400	450	550

Both mechanical and steam agitation were used during the contacting time of one hour. Inspection data on the three filtered oils follow:

Stock	*A*	*B*	*C*
Gravity, deg. A.P.I.	30.1	28.3	26.1
Flash, deg. fahr.	455	500	550
Fire, deg. fahr.	520	575	635
Viscosity at 100 deg. fahr.	332	796	2107
Viscosity at 210 deg. fahr.	54.9	79.5	142.1
Viscosity Index	102	98	101
Color, Tag.-Rob.	11¼	9½	3¼
Carbon, percent	0.15	0.51	1.58
Neutralization Value	0.05	0.05	0.05
Pour Point, deg. fahr.	5	10	20

It will be noticed that oils of Pennsylvania quality have been produced with viscosity indices of around 100. Although the method of obtaining these oils calls for an expensive acid treat resulting in a high loss to sludge, this fact is partly offset because existing plant equipment may be employed to carry out this heavy-acid-treating process.

The lubricating oils produced by the preceding heavy-acid-treating method are believed (as is indicated by physical tests) to be on a par with solvent-treated oils of similar initial quality.

Liquid-to-Liquid Heat Exchangers

Considerations of design and selection discussed . . . and the solution of typical heat exchanger problems explained

By R. H. TURNER

IN this article on liquid-to-liquid heat exchangers and coolers, the term liquid-to-liquid means that the fluid to be heated, usually in the shell, and the fluid to be cooled, usually in the tubes, are both liquids. The first part of the discussion will be mainly on considerations of design and selection, while the latter part will deal with the thermodynamical problem by assuming hypothetical problems and actually rendering them to solution.

The entire theory of liquid heat exchange is based upon the consideration of film transmissions. By that is meant the following: Take the condition of a single cooler reducing the temperature of hot gasoline passing through the shell, or around the tubes, by the circulation of cooling water through the tubes; there is a thin film of gasoline around the outside surface of the tubes and a thinner film of water on the inside of their surface.

The heat of the gasoline is transmitted to the film on the tubes by convection currents set up by an actual attainment of, or an approach to, turbulent flow. The heat is then transmitted to the actual outside surface of the tubes through the film by conduction and passes through the metal of the tubes and the inside water film by the same conduction. It is then transmitted to the cooling water from this latter film by the same convection currents mentioned above. This is the basic theory of heat exchange, but is usually not considered by manufacturers or engineers as existing, except as a foregone conclusion, as of course heat transmission is going on continuously as long as any liquid is passing through the unit. More will be said in detail later on in this paper concerning these films here mentioned when proper temperatures for taking film viscosities are discussed.

Manufacturers in the construction of heat exchangers and purchasers in the buying of units have two distinct questions of economics to consider. These economical deductions should be weighed very carefully by both concerned to eliminate as far as possible any unpleasant occurrences at some future time. This is especially true where one of the mediums to be treated is dirty from suspended foreign matter that will be deposited on the tube surfaces, making necessary the cleaning of the unit or units.

Take for example the cooling of hot tar or still bottoms by cold charging stock that is comparatively clean. Tar invariably contains great quantities of foreign matter, such as coke, etc., which will render heat exchangers partially ineffective after having been in service varying lengths of time, depending upon the rate at which this foreign matter is deposited.

The tar is always the hotter medium and is usually placed in the shell by the manufacturer, unless the contrary is specified. This is done for a very good reason. A much greater rate of heat transfer can be realized, as a greater turbulent flow can be attained by a closer spacing of the shell baffles. Besides this increased transfer rate there is always an increased pressure drop, but usually this can be tolerated.

In addition to the above, the heat transfer rate within the tubes can be raised to a desirable figure, due to the quantity of the charging stock invariably being greater than the bottoms, and only the increased velocity in the tubes will give the increased heat transfer rate, there being no baffles to be taken advantage of. This increased velocity is obtained by increasing the number of passes within the tubes.

As a result of increasing the heat transfer rate a much smaller unit, or fewer units, are required for a given duty, thus resulting in an attractive first cost, with which most purchasers are in accord, for they, too, are more concerned with first cost than with the economical operation of the units after they have been placed in service. But when the time comes to clean these same units, made necessary by their performance falling off, it is learned that it is practically impossible to do so.

An interesting occurrence happened in an East Texas refinery where the chief engineer installed a battery of six bottom units to heat gas-oil charging stock to 355 deg. fahrenheit. When the units were first placed in service the outlet temperature of the gas oil was 385 deg. fahrenheit. An examination of these same units after they had been in service less than three months showed that the gas-oil temperature had dropped to 221 deg. fahr., a loss of 164 deg. fahr., caused by the fouling of the tubes by the dirty bottoms. The performance continued to drop until they were finally removed from service.

In the case just cited it would have been much more desirable and economical to place the tar within tubes of sufficient size and of short length to permit easy and quick cleaning when necessary, regardless of the fact that the first cost would have been materially higher. Manufacturers are forced to do a number of things such as this because of competition and the attitude of the average buyer.

It might be said here further in regard to conditions governing the selection and design of heat exchanger for a given set of specifications, that the size of the unit or units in square footage is no indication of the performance that can be realized by comparative units. It is possible to construct a unit having a total of 1000 sq. ft. that will be inferior in performance to one containing only 300 sq. ft. This can be done by varying the pass arrangement within the tubes and decreasing the shell turbulence, or baffle plates from possibly 12-in. centers down to 1-in. centers. If this be true, then it is a fallacy to consider comparative units solely on a square footage basis.

Let us consider the plausibility of the foregoing by actually assuming definite conditions and see what changes in size of a unit can be made by varying the passes within the tubes, as well as the spacing of the shell baffles.

EXAMPLE: The type shell baffles used in both cases are $\frac{1}{16}$ in. oversized; in other words, they are drilled with holes to accommodate the tubes of $\frac{1}{16}$ in. greater diameter. Tubes used in both cases are 1-in. O.D.

SHELL:

Total heat to be extracted - 3,000,000 B.t.u./hr.

Medium - - - - - - - - - - - - Gas oil
Velocity - - - - - - - - - - - - 3 ft./sec.
Film Viscosity - - - - - - - - - - 32 SSU
Baffle Spacing - - - - - - - - - 4-in. centers
L.M.T.D. - - - - - - - - - 100 deg. fahr.
$3{,}000{,}000/100 \times K$ = total sq. ft. surface required.
K = heat transfer rate = B.t.u./sq. ft./deg. L.M.T.D.

From an examination of heat exchanger curves, K corresponding to a velocity of 3 ft./sec. and a film viscosity of 32 SSU is 45 B.t.u.

TUBES:

Medium - - - - - - - - - - - - Gas oil
Velocity - - - - - - - - - - - - 3 ft./sec.
Passes - - - - - - - - - - - - - - 2
Film Viscosity - - - - - - - - - - 48 SSU

The heat transfer rate corresponding to 3 ft./sec. and 48 SSU is 40 B.t.u.

Then: Overall rate $= 45 \times 40/85 = 21$ plus.
$3{,}000{,}000/100 \times 21 = 1429$ sq. ft. required.

Now let us take the same unit or units and decrease the baffle spacing in the shell to 1-in. centers and increase the number of passes in the tubes to four.

K (shell) corresponding to 3 ft. sec. velocity and 32 SSU film viscosity now is 150 B.t.u.

K (tubes) corresponding to increased velocity of 6 ft./sec. and film viscosity of 48 SSU is 65 B.t.u.

Overall $K = 150 \times 65/215 = 45$ plus.

Surface required $= 3{,}000{,}000/100 \times 45 = 662$ sq. ft.

It readily can be seen from the above that the two units arranged differently will perform the same duty, even though the latter is only 46.20 percent of the former in size.

Another interesting and important consideration in the selection of heat exchangers is that of temperature crossing of the fluids being treated. By temperature crossing is meant the part, or parts, of the exchangers that are rendered ineffective by the cooling medium in flowing its circuituous route coming in contact through the heat of conduction of the tube wall with the fluid to be cooled, which already has been cooled to a lower temperature than the temperature of the cooling medium at that particular point. This condition is usually encountered in coolers where water is used as a cooling medium and consequently is more dangerous in this type of heat exchangers.

In following the subsequent example refer to curves shown in the accompanying chart (Fig. 1), which is explained as follows:

Tc_1 = inlet temp. of cooling medium.
Tc_2 = outlet temp. of cooling medium.
Th_2 = outlet temp. of hot medium.

The abscissae of the curves, or factors, are to be inserted in the formula:

Factor $\times$ (Apparent) L.M.T.D. = (True) L.M.T.D.

In all cases the true L.M.T.D. is less than the apparent L.M.T.D., except in the case of true countercurrent flow where, of course, since there is no temperature crossing, the two are the same.

As a further explanation of the curves, the fractions such as ½, ¼, etc., indicate the pass arrangement. The numerator indicating the number of passes in the shell and the denominator giving the number of passes within the tubes.

EXAMPLE: To cool gasoline entering coolers at 140 deg. fahr. down to an outlet temperature of 90 deg. fahr. while heating water at an inlet temperature of 80 deg. fahr. to an outlet of 100 deg. fahrenheit.

Two coolers in series to be used, having one pass in the shell and two passes in the tubes.

Apparent L.M.T.D. (from L.M.T.D. curve) is 20 deg. fahrenheit.

$$\text{Ratio: } \frac{Tc_2 - Tc_1}{Th_2 - Tc_1} = \frac{100 - 80}{90 - 80} = 2.0$$

Entering curve with a ratio of 2.0 and running horizontally to intersection of curve and reading downward, a factor of 0.83 is obtained. Consequently T.L.M.T.D. $= 100 \times 0.83 = 83$ deg. fahrenheit. In other words, with the above selection there is required 17 percent more surface than would be required if it were possible to have true countercurrent flow.

It might be said here that there are only two countercurrent flow arrangements possible, that of a single-pass both shell and tubes or two-pass shell and tubes, since in floating head construction any greater number of shell passes is most impractical.

If three units were used in the above example, the factor would be increased to 93.50 percent. Further, if two exchangers were used having two passes in the shell and four in the tubes, the factor would increase to 98.50 percent, or approach very near to true countercurrent flow.

A number of different

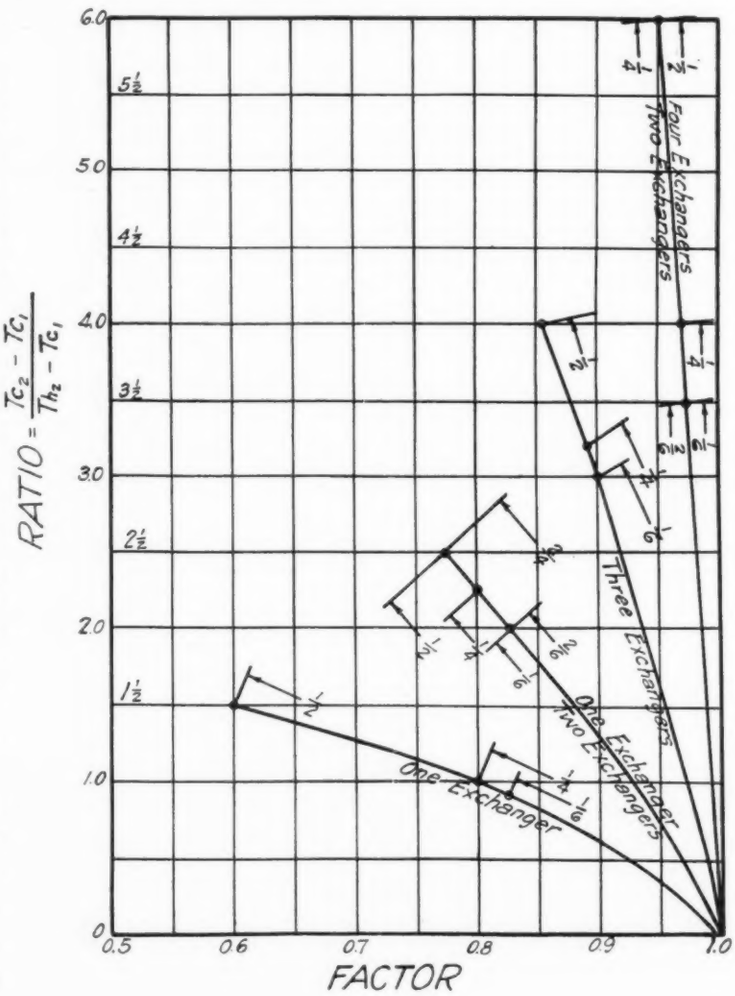


Fig. 1. Chart showing correction factors for L.M.T.D. (log mean temperature difference) — Multipass heat exchangers

Merry Christmas

» » Every member of this organization extends to You Christmas Greetings and best wishes for a Happy and Prosperous New Year

★

THE CONTINENTAL SUPPLY COMPANY

DALLAS TEXAS

baffles are used in the shells of heat exchangers to increase turbulent flow, such as the orifice type, vane-flow, oversized tube hole drilled, disc and doughnut, half-moon, etc., however, the latter two types are more common to vapor coolers and condensers. Certain advantages are claimed for the different types in gaining a greater degree of turbulence with a minimum amount of pressure drop, but all give practically the same performance, except the latter, when dealing with the same set of specifications. Consequently, it may suffice to give here only a short description of each.

The orifice type is one in which the tube holes are drilled 1/64 in. larger than the tube diameter of the tube to give a tight sliding fit. The passage provided for the flow of the fluid are usually 7/16-in. holes drilled between the tube holes.

The vane-flow is one that is continuously run around the tube element while proceeding down the length of the tubes, similar to the rifling in a gun, except that all the tubes, of course, pass through the baffle.

The oversized drilled baffle is one in which the tube holes are drilled either $\frac{1}{16}$ in., $\frac{1}{8}$ in. or $\frac{3}{32}$ in. larger than the diameter of the tubes used, as the particular size is required from the standpoints of tube size, velocity, and pressure drop.

The remaining two baffles are described completely by their names and are of the exact shapes as their names indicate.

It might be thought on first consideration that since velocity is so important in heat-transfer-rate and pressure-drop calculations that there should be short steps for its determination. With that thought in mind the constants listed below are given and explained by examples.

THROUGH SHELL:

V = gal./min. × C × N/No. of tubes in tube element.
V = velocity in ft./sec.
C = constants as listed below.
N = number of passes in shell.

Diam. of Tube Holes

Diam. of Tubes	*in Baffles*	*C*
$\frac{5}{8}$ in.	$\frac{11}{16}$ in.	4.98
$\frac{3}{4}$ in.	$\frac{13}{16}$ in.	4.20
1 in.	$1\frac{1}{16}$ in.	3.15
$1\frac{1}{4}$ in.	$1\frac{5}{16}$ in.	2.47
$1\frac{1}{2}$ in.	$1\frac{9}{16}$ in.	2.14

The above constants are to be used wherever the tube holes in the baffles in the shell are drilled $\frac{1}{16}$ inch larger than the O.D. of the tubes used. The oversized drilling, of course, provides the area for the passage of the fluid in the shell.

Where baffle tube holes are drilled $\frac{1}{8}$ inch larger the following constants are to be used:

$\frac{3}{4}$-in. tubes: C = 2.72
1-in. tubes: C = 2.10

EXAMPLE: Desired to find the velocity through the shell of a heat exchanger using 1-in. tubes. Baffle holes drilled $1\frac{1}{16}$ in. and unit being single pass and containing 315 tubes.

V = 200 × 3.15 × 1.0/315 = 2.0 ft./sec.

THROUGH TUBES:

The same formula holds true for finding velocities through the tubes, but it readily can be seen that the velocity of the fluid must vary as the gauge varies; in other words, as the gauge increases the velocity will increase as the cross-sectional area open to flow is decreased. Consequently, it is necessary to give constants for every gauge that it is desired to use:

O.D. of Tubes	*Gauge*	*C*
$\frac{5}{8}$ in.	16	1.66
$\frac{5}{8}$ in.	18	1.41
$\frac{3}{4}$ in.	14	1.20
$\frac{3}{4}$ in.	16	1.06
$\frac{3}{4}$ in.	18	0.965
1 in.	12	0.667
1 in.	14	0.608
1 in.	16	0.540
1 in.	18	0.503

In the above problem, if 16-gauge tubes were used and the unit were six pass, the velocity would be:

V = 200 × 0.540 × 6/315 = 2.05 ft./sec.

There has been considerable discussion from time to time among engineers concerning the proper temperature at which the viscosities of fluids should be calculated. The proper temperature is, of course, the film temperature, but to calculate this accurately it is necessary to know, among many things, the heat transfer rates and to know these accurately it is necessary to know the exact film temperatures. Consequently the problem devolves itself into an intricate trial-and-error method, which of necessity is of no practical value. It is, therefore, necessary to devise some means to afford a quick method for making these temperature calculations that will be sufficiently correct for all practical purposes. Before solving an actual problem, it may be advisable to discuss this particular point.

Suppose a problem at hand is to cool gas oil of 26 deg. A.P.I. from 500 deg. fahr. to 150 deg. fahr. while heating a particular quantity of this same oil from 90 deg. fahr. to 440 deg. fahr. In both cases the oils are passing through a 350-deg. fahr. range of temperature; however, it would hardly be correct to say that both the film temperatures should be taken as the average temperatures. In the one case this would be 325 deg. fahr., and in the other 265 deg. fahrenheit.

A number of engineers have set upon a particular constant, such as 0.80, to be used to multiply by the heat transfer rate of the medium being cooled to correct for the increased viscosity induced by the cooling effect. The incorrectness of this can be readily seen.

Suppose, for example, that tar of 14 deg. A.P.I. in one case is being cooled from 800 deg. fahr. to 650 deg. fahr., in which range of temperature there is very little change in the tar viscosity, consequently no correction in heat transfer rate would be made; but in another case this same tar is to be cooled from 800 deg. fahr. to 200 deg. fahr., in which there is a material change of viscosity and a sizeable correction must be made. Hence it is fallacious to use a constant correction factor that is not varied according to the temperature ranges.

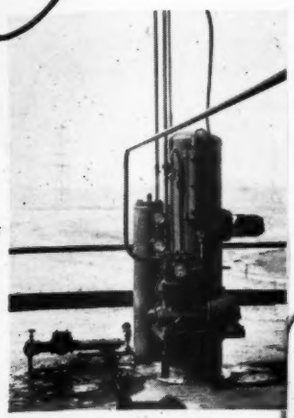
From an almost endless number of both laboratory and field tests the below given formula has been found to be more than sufficiently correct for all practical purposes.

FC = AC + 0.50 × L.M.T.D.
FH = AH + 0.50 × L.M.T.D.
FC = deg. fahr. of film of medium being heated
AC = average temp. of medium being heated
FH = deg. fahr. of film of medium being cooled
AC = average temp. of medium being cooled
L.M.T.D. = log mean temperature difference.

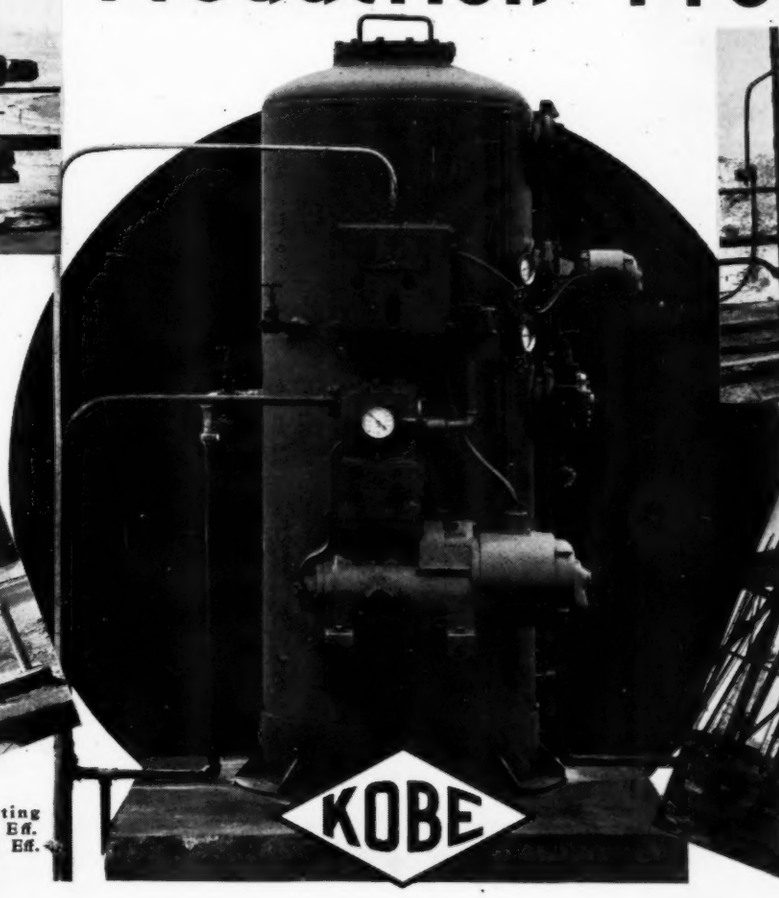
In other words, the film temperature is the average temperature of the medium being cooled minus one-half of the log mean, and the average temperature of the medium being heated plus one-half of the log mean.

To understand more thoroughly some of the foregoing

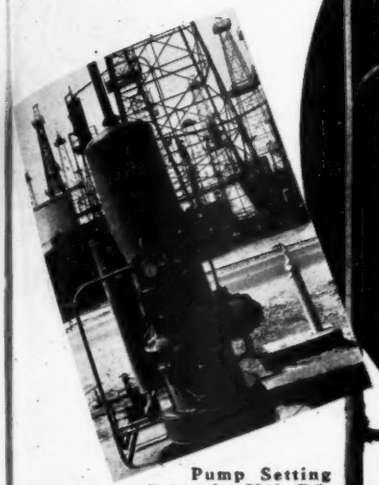
Successfully Meets Every *Condition* AND *Requirement* Of Modern Production Procedure



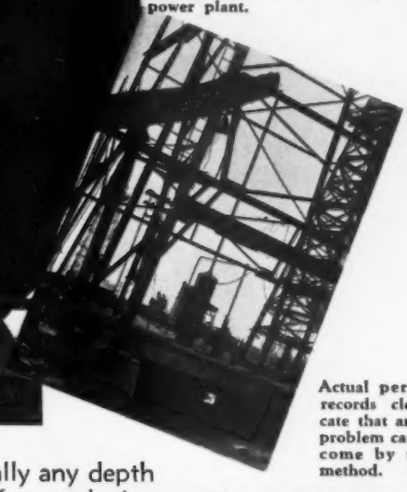
Pump Setting 2,007 ft.
Vol. Eff. 99.9%
Over-all Eff. 37.5%



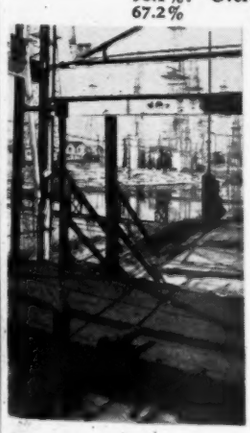
One of a group of wells being operated from a central power plant.



Pump Setting
7,200 ft. Vol. Eff.
96.1%. Over-all Eff.
67.2%



Actual performance records clearly indicate that any paraffin problem can be overcome by the Kobe method.



The Kobe Pump has shown the same comparative efficiencies and economies in crooked holes beyond the range of other methods.

In wells ranging from a few hundred feet to practically any depth — in both straight and extremely crooked holes — for producing individual wells or a group of wells from a central power plant — Kobe performance records show important improvements in both volumetric and over-all field efficiencies.

The fact that it successfully handles conditions beyond the ability of other methods clearly demonstrates its wide range of utility, and also establishes Kobe as the modern method of producing all types of wells.

Detailed performance records which commend it for practically every production requirement will be supplied to interested executives without obligation.

KOBE, INCORPORATED
(Pronounced KŌB)

Manufacturers of KOBE Heat-Treated Screen Casing and KOBE Pumper.
3040 East Slauson Avenue. Huntington Park, California, U.S.A.

Power at the pump and automatic production control.

KOBE HYDRAULIC PUMP

discussion, the following problem is assumed and solved:

Specifications: 1-in. No. 16 BWG tubes to be used.

IN SHELL:

Medium - - - - - - - 36 deg. A.P.I. gas oil
No./Gal. - - - - - - - 7.02 at 60 deg. fahr.
Quantity - - 350 gal./min. (147,200 lb./hr.)
Inlet Temperature - - - - - - 400 deg. fahr.
Outlet Temperature - - - - - 240 deg. fahr.
Viscosity - - - - - 45 SSU at 100 deg. fahr.

IN TUBES:

Medium - - - - - - 36 deg. A.P.I. gas oil
Quantity - - - - - - - - - 350 gal./min.
Inlet Temperature - - - - - - 90 deg. fahr.
Outlet Temperature - - - - - - - - - (?)
Viscosity - - - - - 45 SSU at 100 deg. fahr.

SHELL:

$350 \times 60 \times 7.02 = 147{,}200$ lb./hr.
Sp. heat at 320 deg. fahr — 0.61 B.t.u.

TUBES:

$350 \times 60 \times 7.02 = 147{,}200$ lb./hr.
Sp. heat at 183 deg. fahr. = 0.52

320	183	
640	365	
400	275	— 125
240	90	— 150
160	185	

Apparent L.M.T.D. = 137 deg. $\times$ 0.925 (corr.) = 127 deg.

Total heat = $147{,}200 \times 160 \times 0.61 = 14{,}400{,}000$ B.t.u./hr.

Rise in G.O. (cold): $14{,}400{,}000/147{,}200 \times 0.52 = 185$ deg. fahr.

Approx. surface: $14{,}400{,}000/127 \times 35 = 3220$ sq. ft.

It can be seen from a trial and error examination that a 24-in. diam. unit, or tube element, having 288 1-in. tubes in it will give an economical velocity and approximately three units containing about 3200 sq. ft. of surface should just about take care of this duty.

Vel. = $350 \times 0.540 \times 2.0/288 = 1.32$ ft./sec.
Film temp. = 251 deg. fahr.
Film vis. = 35 SSU.
K (from curves) = 47 B.t.u.
Vel. = $350 \times 3.15 \times 2.0/288 = 5.04$ ft./sec.
Film temp. = 252 deg. fahr.
Film vis. = 35 SSU.
K (from curves) = 120
Overall K = $47 \times 120/167 = 33.80$
Surface required = $14{,}400{,}000/127 \times 33.80 =$ 3350 sq. ft. total.

One 24-in. diam. tube element containing 288 1-in. tubes 14 ft. long contains 1057 sq. ft.; therefore, three such units containing 3171 sq. ft. will suffice, as the original 3350 sq. ft. solution above contains a 30 percent factor of safety in the heat transfer curves from which the rates were obtained.

PRESSURE DROP IN SHELL:

From pressure drop curves for a velocity of 1.32 ft./sec., 35 SSU vis. and 2-in. baffle spacing = 0.10 lb./lineal ft. of travel: Therefore, $0.10 \times 14 \times 3 = 4.20$ lb. $\times$ 1.25 (F.S.) = 5.25 pounds.

PRESSURE DROP IN TUBES:

From pressure drop curves and with 5.04 lb./sec. velocity and 35 SSU vis. and 14 ft. 0 in. tube length per unit, having two passes, pressure drop per unit = 3.0 lb. $\times$ 3 (units) = 9.0 lb. total.

Remmel Completes Trip for Byron Jackson

S. F. Remmel, recently appointed assistant sales manager for the Oil Tool Division of Byron Jackson Company, Los Angeles, made an extended trip through the Mid-Continent, accompanied by C. F. Vincent, Mid-Continent manager for BJ, who introduced him in petroleum circles. Both later attended the A.P.I. convention in Los Angeles.

S. F. REMMEL

Chas. W. East is New Assistant Sales Manager Republic's Pipe Division

Charles W. East, formerly of the Birmingham, Alabama, office of Republic Steel Corporation has been named assistant manager of sales in Republic's pipe division, succeeding George E. Clifford recently appointed district sales manager for Republic in the Los Angeles, California, territory. The appointment was announced by N. J. Clarke, vice-president in charge of sales for Republic.

E. W. Goetz Representing Manufacturing Concerns in North Louisiana

E. W. Goetz, who for a number of years has been identified with the oil industry and the oil equipment manufacturing industry in the Gulf Coast of Louisiana and Texas, has been appointed sales representative of the Cameron Iron Works, Inc., Houston, Texas, and the Rector Well Equipment Company, Fort Worth, Texas. Goetz will represent both companies in the North Louisiana territory, with headquarters at 2719 James Street, Shreveport, Louisiana. He served ten years in the warehouse department of the Gulf Production Company and affiliated interests, and later gained wide experience and formed a wide acquaintanceship in the oil equipment branch of the industry while serving as representative for several prominent tool manufacturers.

E. W. GOETZ

Christmas Trees

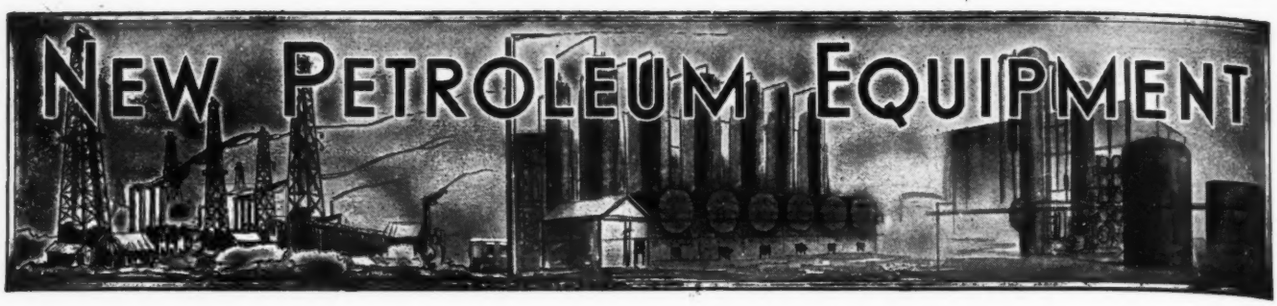
The 'tree in your home, at Yuletide, a monument to Peace, Good Will; symbolic of fellowship . . . hospitality . . . love.

The 'tree on your lease, 365 days in the year, a monument to labor and success; a symbol of a job well done . . .

The OCT Staff extends the Season's Greetings to Oil Men everywhere.

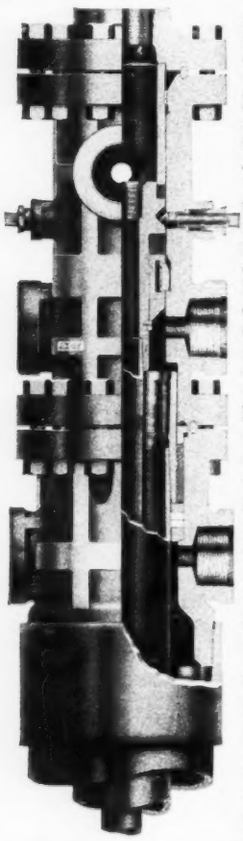
Oil Center Tool Co.

Houston, Texas



Tubinghead-Bradenhead Combination Oil Center Tool Company

OIL Center Tool Company, Houston, Texas, is on the market with a new tubinghead-bradenhead combination that enables the operator to flange the complete Christmas tree assembly directly onto the bradenhead, avoiding the use of nipples between the oil string of casing and the surface hookup.



The equipment involved in this combination is the Type "AS" streamline tubinghead and the new OCT Type "C-3" bradenhead. Through its use, the Christmas tree can be flanged on top of the bradenhead, and blowout preventer equipment flanged on top of the entire Christmas tree before drilling the plug. Thus can the operator drill in, run and land tubing in the Christmas tree body before removing blowout preventer equipment.

Type "C-3" bradenhead is built to screw into the surface casing collar. Tubinghead is flanged on top to accommodate any make of blowout preventer through the use of OCT adapters made for this purpose. The combination, according to the manufacturers, makes a positive seal around the oil string of casing, since the bradenhead furnishes a double pack-off, one set of packing sealing around casing and the other sealing around the casing collar, as shown in the accompanying illustration. The combination eliminates threads between the bradenhead, the oil string, and the Christmas tree. While the illustration here shows a design for male thread valves, this hookup is made for use with any manufacturer's valves.

The new combination is furnished in test pressures up to 6000 pounds.

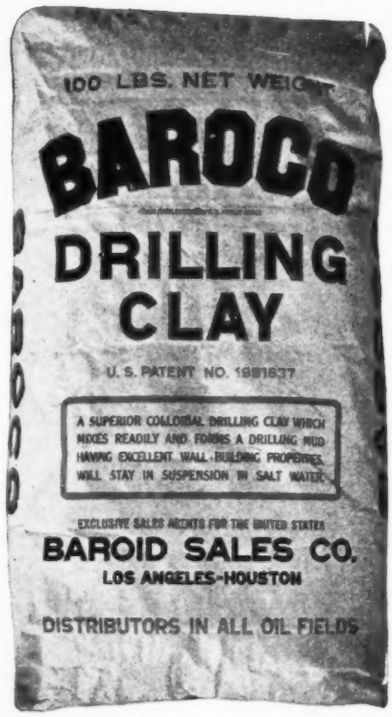
Baroco Drilling Clay Announced by Baroid Sales Co.

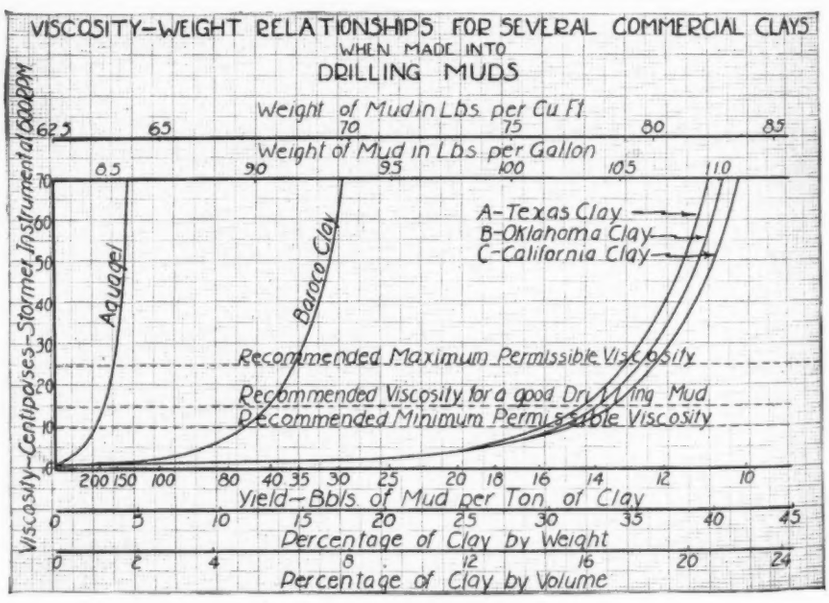
BAROID Sales Company, Los Angeles, California, and Houston, Texas, announces Baroco, a new drilling clay for Mid-Continent and Gulf Coast operators. According to the manufacturers, one ton of Baroco makes 40 bbl. of excellent 15 centipoise drilling mud and saves from 25 percent to 50 percent in the cost per barrel.

Baroco, when mixed with water, will make a most satisfactory drilling mud for all-around use. Because it contains an extraordinarily high percentage of gel-forming colloidal matter it is said to build an excellent wall quickly, with a consequent proportional reduction in drilling difficulties.

In addition, Baroco clay is specially selected and processed to resist the "flocculating" action of salt and salt waters. Mud made from Baroco is substantially unaffected by contact with salt or salt waters, the makers claim, and satisfactory drilling muds can be made by mixing Baroco directly with salt water. Baroco is especially recommended by the manufacturer for drilling on salt domes or where it is expected that salt water will be encountered.

Complete information regarding Baroco clay can be obtained by writing the Baroid Sales Company, Second National Bank Building, Houston, Texas. Stocks are carried and service men available in Mid-Continent and Gulf Coast oil fields.


100 LBS. NET WEIGHT
BAROCO
DRILLING
CLAY
U. S. PATENT NO. 1881637
A SUPERIOR COLLOIDAL DRILLING CLAY WHICH MIXES READILY AND FORMS A DRILLING MUD HAVING EXCELLENT WALL-BUILDING PROPERTIES. WILL STAY IN SUSPENSION IN SALT WATER
EXCLUSIVE SALES AGENTS FOR THE UNITED STATES
BAROID SALES CO.
LOS ANGELES-HOUSTON
DISTRIBUTORS IN ALL OIL FIELDS


VISCOSITY-WEIGHT RELATIONSHIPS FOR SEVERAL COMMERCIAL CLAYS
WHEN MADE INTO
DRILLING MUDS
Weight of Mud in Lbs. per Cu Ft
62.3 65 70 75 80 85
Weight of Mud in Lbs. per Gallon
8.5 9.0 9.5 10.0 10.5 11.0
A-Texas Clay
B-Oklahoma Clay
C-California Clay
Aquagel
Baroco Clay
Recommended Maximum Permissible Viscosity
Recommended Viscosity for a good Drilling Mud
Recommended Minimum Permissible Viscosity
Viscosity-Centipoises-Stormer Instrument 600 RPM
200 150 100 80 40 35 30 25 20 18 16 14 12 10
Yield-Bbls. of Mud per Ton of Clay
0 5 10 15 20 25 30 35 40 45
Percentage of Clay by Weight
0 2 4 8 12 16 20 24
Percentage of Clay by Volume

Percentage solids—viscosity relationship of Baroco and typical native clays (curves A, B, and C) used in Mid-Continent and Gulf Coast fields for making up drilling muds

Airco-DB Style 8490 Heavy-Duty Regulator

THE Air Reduction Company announces a new heavy-duty type two-stage reduction regulator. This regulator, Airco-DB style 8490, was primarily designed to deliver large volumes of oxygen

at relatively high pressures such as may be encountered on heavy cutting, deseaming jobs, furnace tapping, and in similar operations. It finds its use principally where the oxygen demand is greater than can be handled by the conventional regulator, the manufacturers state, or where close pressure regulation and a low end-point are desired. A further and important use of the regulator arises in cases where precise pressure regulation with medium flows is involved. And, whenever the oxygen demand per regulator is in excess of 1000 to 1200 cu. ft. per hour, the "8490" should be used even if the low end-point and close regulation are not essential, it is pointed out by the makers.

The Airco-DB Style 8490 regulator is of the two-stage pressure reduction type. The maximum operating pressure is 200 lb. per square inch. The maximum delivery capacity is on the order of 3000 cu. ft. per hour, providing the delivery pressure is 100 lb. or greater. The pressure regulation furnished by the regulator is practically independent of the rate of flow from full cylinder pressure down to the regulation end-point. The pressure variation will generally be less than plus or minus one-half lb. per square inch.

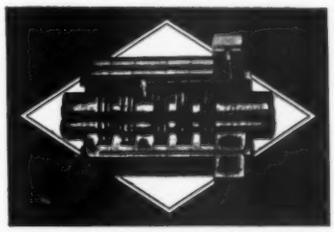
Marking a radical departure from conventional regulator design, this regulator uses the Airco laboratory-developed "feed-back" principle, the manufacturers point out. The low-pressure cavity is connected to the space in back of the first-stage diaphragm by the passage through the control tube on the back of the regulator. The first-stage spring maintains a certain difference in pressure between the first and second stages, much in the same manner as in the usual two-stage welding regulator, although the pressure difference varies in the latter for different operating pressures. However, whenever the adjusting screw is turned in, and pressure developed in the low-pressure cavity, the same pressure will be developed in back of the first-stage diaphragm; this pressure augments the effect of the control thrust so that the first-stage pressure increases by an amount equal to the operating pressure.

The effect of the control tube is the same as if the first stage side of the regulator were equipped with an adjusting screw of its own and this screw were turned in the same amount as the operating-pressure adjusting screw (for equivalent characteristics, a long and heavy control spring would be required). With this arrangement, the difference between the first- and second-stage pressures is always maintained substantially constant, with the difference being equal to the first-stage pressure when the adjusting screw is entirely released.

This feature is said to be largely responsible for the excellent regulation that is obtained with this regulator, because there is a definite relation between the first- and second-stage pressures that will give the best regulator characteristics. In welding regulators, the available pressure range is small compared to the pressure range of a cutting regulator, thus a varying pressure differential between the two stages is not so important as in the cutting regulator. By using the feed-back principle, the two stages keep pace with each other and the size and weight of the regulator are reduced a great deal from the size and weight of the regulator having comparable performance and using the usual two-stage principle, the manufacturers state. This is because the "8490" regulator uses gas pressure to accomplish what a very long and heavy control spring otherwise would do.

More Evidence that

COOK'S METALLIC PACKINGS . .



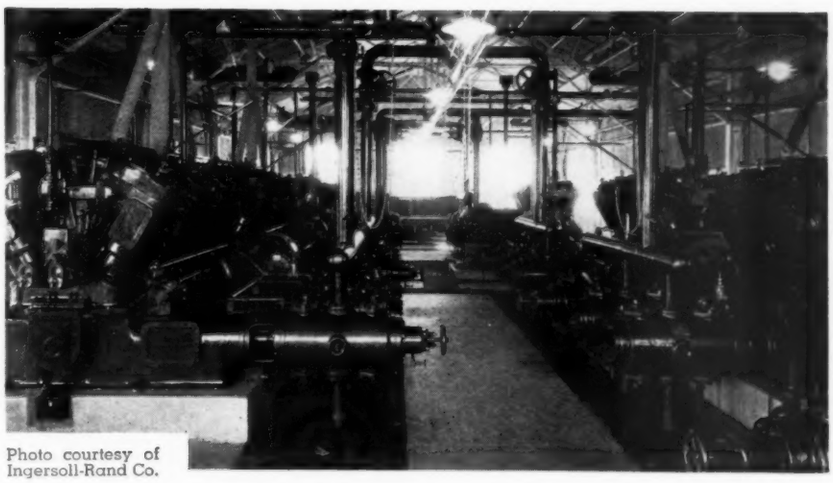


Photo courtesy of Ingersoll-Rand Co.

. . . PREDOMINATE IN THE NATURAL GASOLINE INDUSTRY

Any engine or compressor is a more efficient unit if its rods are fitted with COOK'S Metallic Packing. A noteworthy application is represented by Ingersoll-Rand Gas Engine Driven XVG Compressors—like those shown above—that come factory-equipped with COOK'S Compressor, and Oil Return Packings.

"Sealing Pressure Since 1888"

WRITE FOR INFORMATIVE LITERATURE . . . SPECIFY MAKE AND TYPE COMPRESSOR YOU OPERATE

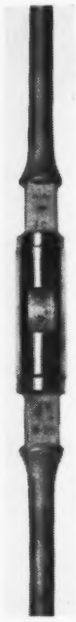
C. LEE COOK MANUFACTURING CO.

INCORPORATED

New York Cleveland Baltimore Los Angeles LOUISVILLE, KY. Chicago Tulsa New Orleans San Francisco

National Develops New Line of Sucker Rods

THE National Supply Company recently introduced a new line of integral upset end sucker rods made to A.P.I. specifications in box and pin and double pin types.



In the development of these rods, National conducted extensive laboratory and field tests to determine the proper materials from which to manufacture sucker rods to meet all pumping conditions.

These tests clearly indicated to National's engineering staff the necessity of producing five grades of sucker rods to meet the varying operating conditions and to combat the corrosive conditions existing in many fields. The five grades developed are Grades 30, 40, 50, 80, and 90.

Grade 30 is an improved carbon rod of good strength and ductility and will give excellent service in light to medium heavy wells where the fluids are non-corrosive and sulphides are light, the manufacturers state.

Grade 40 is a medium manganese rod of somewhat greater strength than 30, good for medium heavy wells with non-corrosive fluids and light sulphides.

Grade 50 is a high manganese, high-strength rod, intended for the heaviest loads in non-corrosive and non-sulphide fluids.

Grade 80 is a medium nickel molybdenum alloy, which will handle medium heavy loads in badly corrosive and medium sulphide fluids.

Grade 90 is a high nickel alloy, recommended for heavy loads in badly corrosive and heavy sulphide wells.

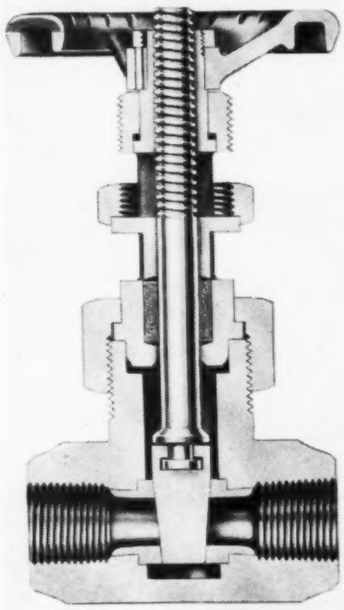
Properly to manufacture this line of rods a new plant was established at Carnegie, Pennsylvania, equipped with the most modern machinery and furnaces. All equipment is entirely new and especially designed for the single purpose of making National sucker rods.

The National Supply Company's Bulletin No. 82 fully describes this new line of sucker rods and illustrates in detail the various steps of manufacture. It will be sent free upon request.

New Chapman Valve Carries Five-Year Guarantee

A NEW gate valve, machined from solid steel bar stock and carrying a five-year guarantee, is now being introduced by The Chapman Valve Manufacturing Company, Indian Orchard, Massachusetts. The new valve, List 960, is made in all standard sizes from ¼ in. to 2 inch. It is designed for all services up to 600 lb. pressure at 800 deg. fahrenheit. Sizes ¼ in. to 1 in. are designed for cold working pressures of 2500 lb.; larger sizes for 1500 pounds.

It is stated that the new valve offers economies not only because of its wear-



ing qualities and freedom from repairs, but also because it can be employed as standard small-valve equipment throughout a power or process system, eliminating the need of stocking a variety of types.

Unlike the globe valves, the List 960 has no pockets, raised seats or constrictions, the manufacturer states; in the open position it forms a virtually unbroken continuation of the pipe line. It can be repacked under pressure.

The valve is fitted with stainless steel valve stem, plug, and seat rings. These parts are easily renewable. The unconditional guarantee that accompanies each valve states that the company "agrees to replace without charge any working part or parts of any valve that fails from any cause within five years from the date of installation."

For extremely corrosive service the List 960 is manufactured in monel, stainless, and other special alloys.

Portable Kelly Straightener of Baker Oil Tools, Inc.

A NEW portable, hydraulically operated device for straightening a kelly or drill pipe has been announced by Baker Oil Tools, Inc., of Los Angeles, California.

Easily transported to the derrick floor, it is claimed that this straightener will effectively take out kinks or bends while the

kelly remains in its normal operating position suspended in the derrick. It eliminates the necessity for laying down the kelly with the risk of further bending; and removes the possibility of kinking the kelly while transporting it to or from the shop, or dragging it into the rig.

The hydraulic ram exerts a pressure of 78 tons, and functions equally well in any position. Minimum time is required for the straightening operation, so that shut-down time is practically eliminated as compared with the previous method of transporting the kelly to and from a shop, the manufacturers state.

Allis-Chalmers Extends Its Line of Duro-Brace Texsteel Shreaves

DUE to their light weight, great strength and pleasing appearance, texsteel sheaves for V-Belt drives have become so popular that additional stock sizes have been added by Allis-Chalmers Manufacturing Co., Milwaukee, Wisconsin, now making it possible to furnish duro-brace texsteel drives up to 15 hp., it is announced. The grooves of the entire texsteel line are so designed that they can be used with A section belts (½-in. x 11/32-in.) or with B section belts (21/32-in. x 7/16-in.) depending upon the application. The standard line now includes 25 different diameters of sheaves from 3 in. up to 18 in., inclusive, for any number of grooves from two to six, inclusive, or 125 different duro-brace texsteel sheaves. All of these sheaves are now available with interchangeable type hubs that are carried in stock with bores

in 1/16 in. increments from ½ in. up to the maximum bore.

Entering the new year, Emsco presents a complete line of drilling and production equipment that in improved design and construction is fitted to the period ahead, is entirely dependable for wells of any depth, and will continue to set the pace for safety, efficiency and economy in service.
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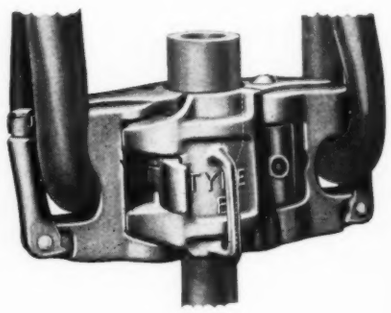
Elevators For External Upset Drill Pipe

TWO new designs in elevators for handling external upset drill pipe rapidly and safely without the use of lifting plugs have been developed by the Byron Jackson Company of 2150 Slauson Avenue, Los Angeles, California. These elevators are designed to support and lift the pipe by the upset and will safely withstand all wedging strains imposed upon an elevator by external upset pipe, the manufacturers state. One style is the BJ Type "B" for side door operation; the other is the BJ Type "G" for those operators who prefer a center latch elevator.

The opening in the Type "B" side door elevator is amply wide to receive the drill pipe below the upset. When the load is taken, the upset fits into a recessed and tapered upper portion of the body and cannot then come out until the load is released and the elevator dropped below the upset. Automatic safety is provided by the door. Even though the door may not be entirely closed by the derrickman, positive closing is insured by a specially designed "two-step" feature, the makers point out. The second step retains the door in position after it moves to within approximately ¾ in. of the closed position. When the load is taken, the door is automatically forced inward to latch the door completely and positively in place. The door is actually a large connecting latch that prevents the body from spreading under the wedging action imposed by the upset when extremely heavy loads are carried.

The Type "G" center latch is made in two halves split in the center with the latch opposite the hinge. With this type,



the wedging action of the upset is taken care of by a heavy "stirrup-type" latch that fits over two strong lugs, one on either half of the body. This eliminates all strain on the latch pin that merely has to serve as a hinge for the latch and hold it in position after the elevator is closed.

The inner bore has the same contour for the upset as provided in the side door type. The "stirrup-type" latch makes the elevator safe against accidental opening and the long handles provided are equipped with guards to protect the hands of the operator.

Both the Type "B" and Type "G" elevators are made of a shock-resistant, alloy steel, heat treated and drawn to a hardness that will not upset or break down under the terrific strain caused by continual pounding and wedging, the manufacturers state. A standard grease-gun connection permits proper lubrication of the hinge pin which is protected from accumulation of dirt. Further details will be furnished by the manufacturer upon request.

To Our Friends

Everywhere . . .

We extend our wish

for a Happy Christmas Season

and the hope

that Fluid Packed Pumps

may contribute

to their prosperity

during the

New Year

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Phase-Rotation Indicator

A new type phase-rotation indicator, in which the outstanding innovation is the complete lack of moving parts, has

been announced by the General Electric Company, Schenectady, New York.

Weighing only 12 oz. and having overall dimensions of 5½ in. by 3½ in. by 3 in., it can be carried around easily. This instrument will be found very useful in three-phase testing and installation work, such as the testing and installation of three phase meters and motors, the manufacturers state.

The new phase-rotation indicator employs two neon glow lamps and a simple circuit that requires no adjustment. Suitable terminals are provided for connection to 110-, 220-, or 440-volt circuits.

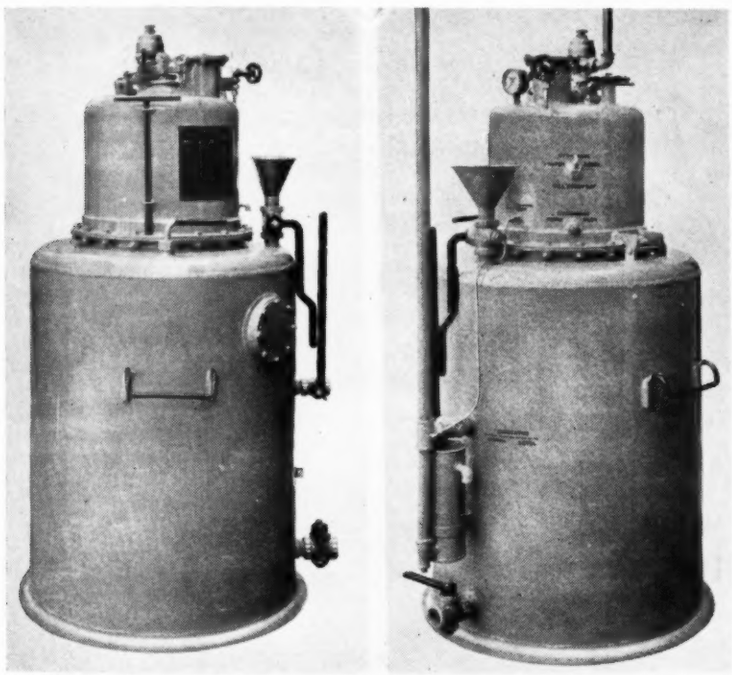
Operation is simple and sure. Pressing a centrally located button lights both of the glow lamps. The button is then released—and phase-rotation, clockwise or counterclockwise, is shown by which one of the lamps remains lighted.

Small Medium-Pressure Generator Announced

A new small-size medium-pressure acetylene generator for portable or stationary service has been announced by The Linde Air Products Company, 30 East 42nd Street, New York. Known as

Skillful design, and the extensive use of pressed steel parts and bronze-welded galvanized steel sheet result in a neat, sturdy, and extremely compact unit.

There is practically no exposed piping,



The Oxweld MP-6 Medium Pressure Generator: left, for portable service; right, equipped with overflow seal pot, vent tube, and vent pipes for stationary service.

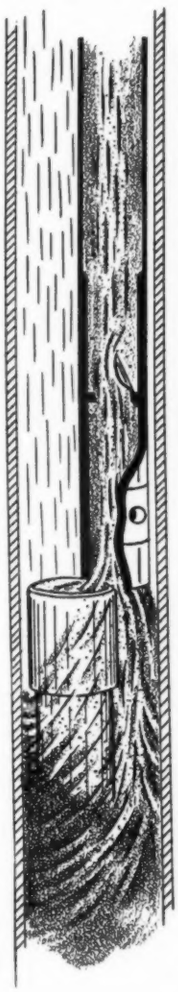
the Oxweld Type MP-6 Medium Pressure Generator, this latest addition to the Oxweld line of generating equipment has a 50-lb. carbide capacity with a double rating of 100 cu. ft. of acetylene per hour. Developed for portable or stationary use with any type of oxy-acetylene cutting or welding apparatus, it meets the demand for small, rugged, low-priced generating equipment of modern design, the manufacturer states.

A handwheel at the generator top makes it possible to control the carbide feed so that acetylene at any desired pressure up to 14 lb. per sq. in. may be obtained. The carbide feeding mechanism incorporates the same principle of gravity type, pressure diaphragm-control as the larger Oxweld Types MP-4 and MP-5. and such operating mechanism as the feed control, carbide hopper, hydraulic backpressure valve, and filter are all assembled within the dome-shaped top of the generator. The dome may be tilted back if access to the interior is necessary.

Special automatic controls make the Oxweld Type MP-6 generator particularly safe to operate. It has been tested and accepted by the Underwriters' Laboratories at the double rating for generating capacity. In addition, it has been listed for both stationary and portable service.

The generator can be mounted on a truck for transportation from job to job, or fitted for permanent installation to supply medium-pressure acetylene through pipe lines.

THE CAVINS is used for the FOLLOWING PURPOSES



1. Breaking hard-packed sand bridges. Also, ordinary sand may be cleaned out in about one-third the time formerly required for this purpose.

2. By attaching a junk trap or basket to bottom The Cavins will easily recover such "fish" as pins, cones, discs, cuttings of all kinds, rubber, etc.

3. Cleaning the perforations, or screen. During the ordinary bailing operation, sand will be drawn into the tool from behind the pipe, due to the sudden opening of the valve.

4. Cleaning out sand bridged tubing.

5. Cleaning out sand around and inside the "fish" in order to permit a socket or other fishing tool to grip the "fish." (See illustration.) The bailer with a suitable shoe, or bottom, is used for this purpose.

6. Setting liners.

7. Bailing lead cuttings from lead plugs.

Write or telephone for detailed information regarding The Cavins in any of the services listed.

THE CAVINS COMPANY

Long Beach, Cal., 2853 Cherry Ave.—Phone 414-14
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Bakersfield, Cal., 3800 Chester Ave.—Phone 1779J
Taft, Cal., 200 Center St.—Phone 78
Goleta, Cal.—Phone 8213
Santa Paula, Cal.—Phone 234
Houston, Texas—Phone Wayside 1451
Kilgore, Texas—Phone 753
Pampa, Texas—Phone 1220
Oklahoma City, Okla.—Phone 3-6441
Wichita, Kansas—Phone 45-449
Lyons, Kansas—Phone 227

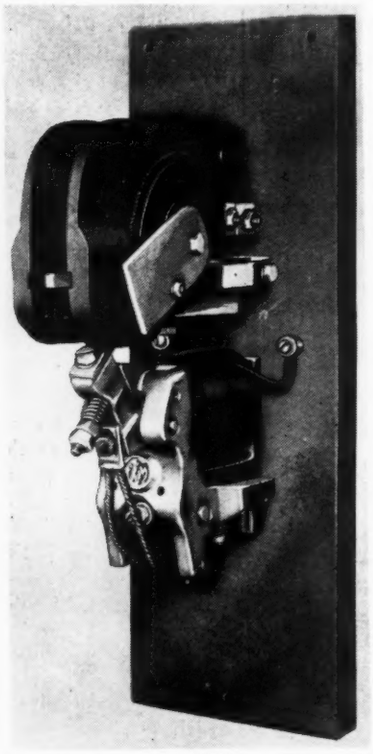
Detector for Hydrogen Sulphide

MINE Safety Appliances Company, Pittsburgh, Pennsylvania, has announced the development in its research laboratories of a hand-operated instrument for quick, accurate detection and measurement of low but dangerous concentrations of hydrogen sulphide in air. Known as the MSA Hydrogen Sulphide Detector, the instrument permits direct readings of the toxic gas in concentrations from 0 to .04 percent, and can be operated by the ordinary workman.

Line-Arc Magnetic Contactors

FOR use on d.c. applications, The Electric Controller and Manufacturing Company, 2698 East 79th Street, Cleveland, Ohio, announces a complete line of new magnetic contactors up to and including 800 ampere capacity, in which the arc, formed as the circuit is opened, is ruptured harmlessly in a narrow path or line centered between, but not touching, the arc shields.

Line-Arc contactors are made of a strong, aluminum alloy with magnetic parts of rolled steel that has the advantage of light weight and low inertia



of moving parts, permitting extremely quick response and high speed operation. Operating coils are designed for continuous operation on d.c. voltages of 230 volts or less.

As the contacts of these new Line-Arc contactors start to separate, the arc is immediately removed from the contact tips. One end of the arc travels rapidly up the circular copper guard over the blow-out coil and the other end moves in the opposite direction along a horizontal arcing plate between the front of the arc shields. In this manner the arc is stretched out in a narrow path or line between, but not touching, the arc shields.

The Line-Arc principle causes the arc to break clean. The arc is not allowed to play around on local areas and under normal conditions, the contacts never even reach the temperature of electronic emission. Contact life of Line-Arc contactors has been vastly increased over any existing standard of comparison, the manufacturers claim. There is no consumption of metal in the arcing plate and blow-out guard, because of the constantly changing terminals of the arc and the speed with which the arc is moved along these parts, it is stated.

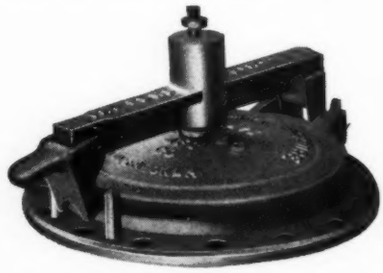
Automatic Latch On Enardo Thief-Hatch

A "step-on" spring bail that serves as an automatic latch is now offered in the full line of thief-hatches made by the Enardo Manufacturing Company of Tulsa, Oklahoma. Hatches are furnished with or without the bail.

Eight models of hatches are offered in all-aluminum and eight in gray iron. The models include a round hatch and a long hatch, both made in the 2-in. base and the 10-in. base, and both with and without the automatic latch "step-on" spring bail.

A felt backed, gasoline- and oil-proof cork fibre gasket is used on all models and is so arranged that ice and dirt will not gather on it and prevent its proper functioning.

The eight all-aluminum models will not spark when struck by metal and thus form a safety precaution against the hazard of fire, the manufacturers state. Also the tall 10-in. model eliminates the necessity of installing an iron collar on water-seal tanks, it is pointed out.

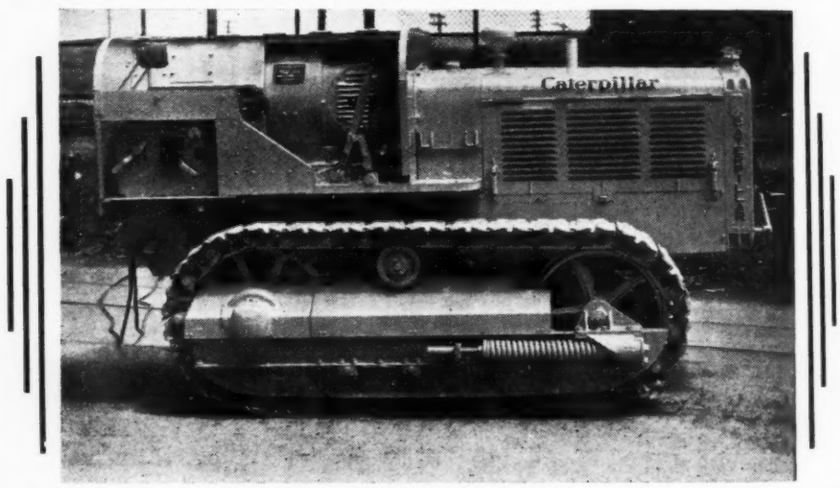


The thief-hatch opening on the round model is eight inches in diameter and the long model is 7¾ by 17½ inches.

Special interest has been manifested in the models with the "step-on" spring bail, the makers say. It eliminates much of the danger of getting the head too close to the opening and breathing fumes from the tank. Also time is saved as there is no bolt or set screw to turn. When the lid is flipped over it latches in an automatic fashion. It also may be opened by the foot.

"Caterpillar" Designs Welding Unit

A COMPACT electric welding unit designed by Caterpillar Tractor Company, Peoria, Illinois, has been announced as a standard addition to the company's line of products. This unit consists of a General Electric generator and a "Caterpillar" Twenty-Eight Tractor.



Because of its flexibility, short turning, and track-type construction, this outfit is able to get into otherwise inaccessible spots along railroad right-of-ways, the manufacturer states. It can be driven over rails, steep shoulders, and can rest alongside the track, clear of traffic while welding is progressing. Its drawbar is also free for pulling jobs often found unexpectedly along a section during track repair.

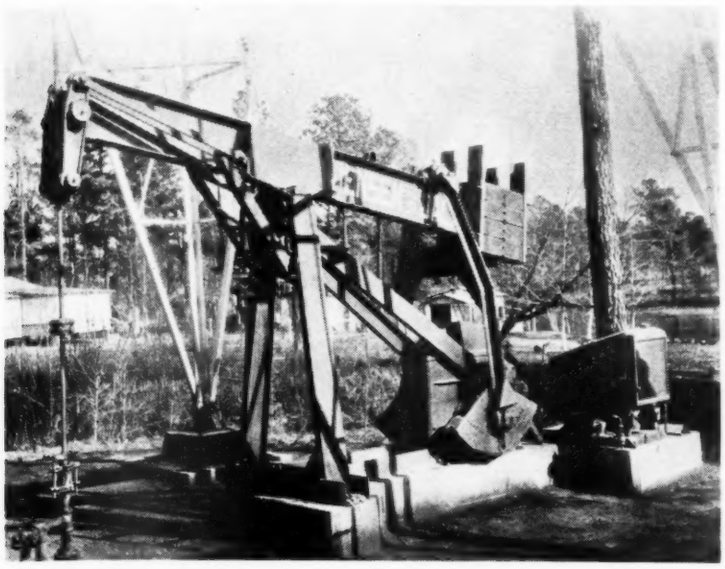
The transportation field is only one of the many to benefit from the new unit, it is stated. It has been declared ideal for use in the oil fields and on pipe line welding jobs. It also offers a means of quick repairs in shipyards and other structural work.

From the tractor engine flywheel back the platform has been redesigned to include an enclosed generator and equipment, with maximum efficiency of the welder unit in mind. The design attains compactness through arrangement of generator and its accessories. The top of the welder section is only a few inches higher than the tractor hood. Controls and seat have been moved to the right, permitting comfortable and convenient tractor operation.

The generator is 300 amperes, 40-volt and of the d.c. type. It is operated by power take-off at the rear of the tractor through a V-belt drive. The control panel is handily located on the right rear side of the tractor. Compartments are built at the rear of the unit for reeling and storing welding cable and to keep an ample supply of welding rods. A hinged steel cover and compartment doors fitted with hasps and locks, protect the entire assembly and tractor operating space from pilferage and weather.

Straight Lift Oil Well Pump Is All Arc-Welded Construction

A STRAIGHT lift pumping unit of all arc-welded construction that can be used for pumping oil wells up to 3500 ft. deep on 2-in. topping is announced by Jen-



sen Bros. Manufacturing Company, Coffeyville, Kansas.

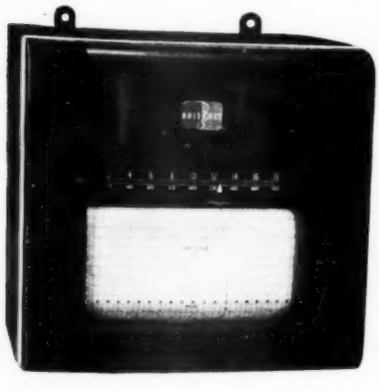
The pump, shown in the accompanying illustration, is entirelv fabricated by arc-welding. The various parts are welded into one integral piece of steel by the electric arc. The main beam of the pump is 15 inches. The fixed legs are sections of channels welded to angles at the bottom and supporting the main beam. Other parts of the pump are standard sizes of plate, bar stock, angles and tubing, all fused together. The pump was built with shielded arc-welding equipment supplied by The Lincoln Electric Company, Cleveland, Ohio.

The pump shown in the illustration is in operation by the Virginia Oil Company, on its Lake Harris lease, Lake Harris, Texas.

Potentiometer Pyrometer of The Bristol Company

THE Bristol Company, Waterbury, Connecticut, as an addition to its line of industrial instruments, the Wide-Strip Pyrometer, available in single-record, multiple-record, and recorder-controller types. This instrument, operating on the potentiometer principle of temperature measurement, has a built-in accuracy made possible by a simple measuring, balancing, and recording mechanism, the manufacturers state.

A stainless steel lead screw, operated by an electrical motor under the direction of two galvanometer-controlled contacts, adjusts the slide-wire contact and record-



ing-pen unit to maintain emf balance in the potentiometer system. This mechanism introduces a new principle of operation into temperature measurement by means of the potentiometer method, it is pointed out.

The design of the balancing mechanism is such that all mechanical backlash is taken up, it is stated, making it possible to magnify scarcely perceptible deflections of the galvanometer pointer. No clearance is required between the pointer and the chopper arms. Deflections smaller than 1/1000 of an inch are easily measured, it is claimed.

The pen movement is always proportional to the size of the galvanometer deflection, accounting for the quickness with which balance is restored and for the speed with which temperature changes are written on the chart. The slide wire contact and recording pen are mounted on the same carriage, greatly simplifying the mechanical construction of the instrument and eliminating errors due to backlash, lost motion, etc.

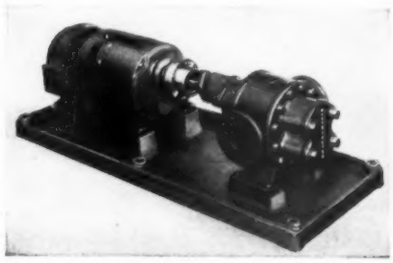
The carriage on which is mounted the slide wire contact and recording pen runs on four wheels over a substantial two-rail track. Three-point contact with the rails insures positive motion. It is driven through engagement with a hardened-steel pin by a stainless-steel lead screw. The lead screw, mounted on permanently lubricated ball bearings, is positively driven by an induction type motor. No friction clutches nor ratchet mechanisms are used, it is stated.

In addition to these features Bristol's Wide-Strip Pyrometer records on a 12¼ in. chart; is equipped with a 1¼ in. indicating scale that can be read easily at a distance; uses a heavy-duty galvanometer totally enclosed in a dust-proof case; has a duplex slide wire mounted in such a position that the slide-wire contact and pen are integrally mounted on the same carriage; is designed and constructed to withstand an unusual amount of neglect and misuse; is housed in a convertible case that is moisture-, fume-, and dust-proof; is fully automatic in operation; is simple in construction; and is easy to service in the field by the user..

Bristol's Wide-Strip Pyrometer is described in Catalog 1450, available to those requesting copies.

Worthington Rotary Pumps

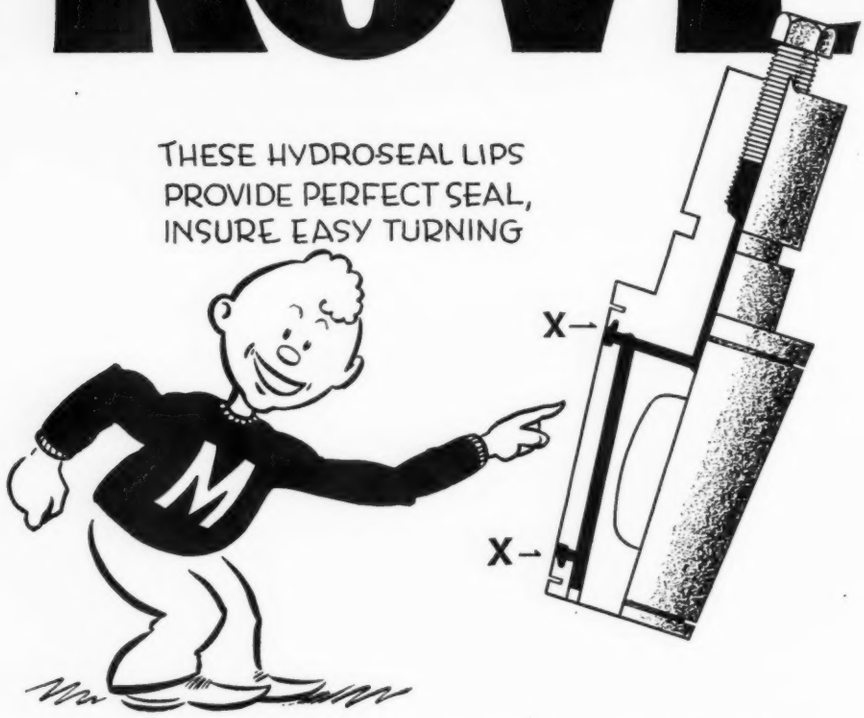
HEAVY DUTY rotary pumps are now produced by Worthington for efficiently pumping practically all kinds of clean liquids—thin, thick, viscous, hot, cold, corrosive—liquids not easily handled by other types of pumps, including those that solidify when cool, such as asphaltum, rosin, lard, soap, etc. Complete lines of standard and steam-jacketed pumps of this type are made to handle pressures up to 300 lb. per sq. in., temperatures up to 650 deg. fahr., with capacities of from 10 to 2500 gal. per minute. For viscous and solidifying liquids the pumps are steam-



jacketed. For high temperatures the stuffing boxes are water-jacketed. Internal sleeve and internal roller bearings are used for non-corrosive liquids; external ball bearings for corrosive liquids. These pumps are exceptionally efficient over a wide pressure range, the makers claim. The continuous-tooth double-helical gear rotors, eliminating all end thrust, are mounted on unusually stiff shafts with large, high-capacity bearings. The pumps give straightway, continuous, non-churning and non-foaming discharge, the manufacturers state. No valves. No gaskets. No trappings of liquid. No pulsations. All parts easily accessible. The single extra deep stuffing box on the internal bearing type pump is subject to suction pressure only. These pumps operate quietly, readily handle considerable vapor, air or gas suspended in the liquid, and require practically no attention, it is stated. Practically any drive arrangement is applicable. The pumps have been successfully employed for a wide variety of difficult services and have proved themselves to be notably dependable and durable, it is pointed out.

On request, Worthington Pump and Machinery Corporation, Harrison, New Jersey, will send a descriptive bulletin covering this equipment. Ask for W-475-B8.

PROVEN



With "Hydro-Seal" lips no packing nor packing glands is used, thereby eliminating unnecessary friction. The plugs on high pressure models turn on ball bearings. MacClatchie valves turn easily, hold more pressure and last longer. A turn of the lubrication screw thoroughly lubricates the plug and body and expands the "Hydro-Seal" lips.

Users throughout the world are finding that MacClatchie valves are the answer. SPECIFY THEM AND BE CONVINCED.

"Hydro-Seal" Lips constitute the greatest improvement in PLUG VALVES since their conception. Undercut grooves in the surface of the plug form metal "Hydro-Seal" lips which are expanded by grease pressure applied by a booster screw. The fine, razor-like edges of the "Hydro-Seal" lips engaging against the wall of the body make escape of pressure impossible.

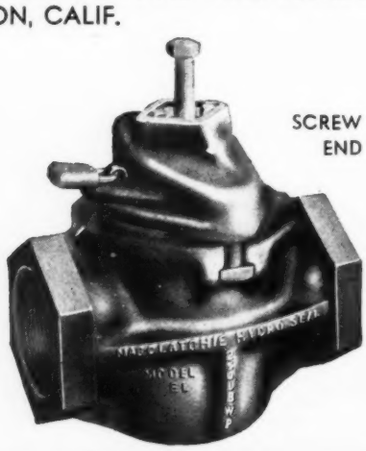
Sold by Supply Stores Everywhere

MacCLATCHIE MANUFACTURING CO.

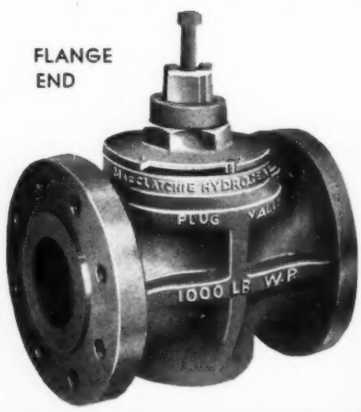
COMPTON, CALIF. HOUSTON, TEXAS

UNION END

SCREW END



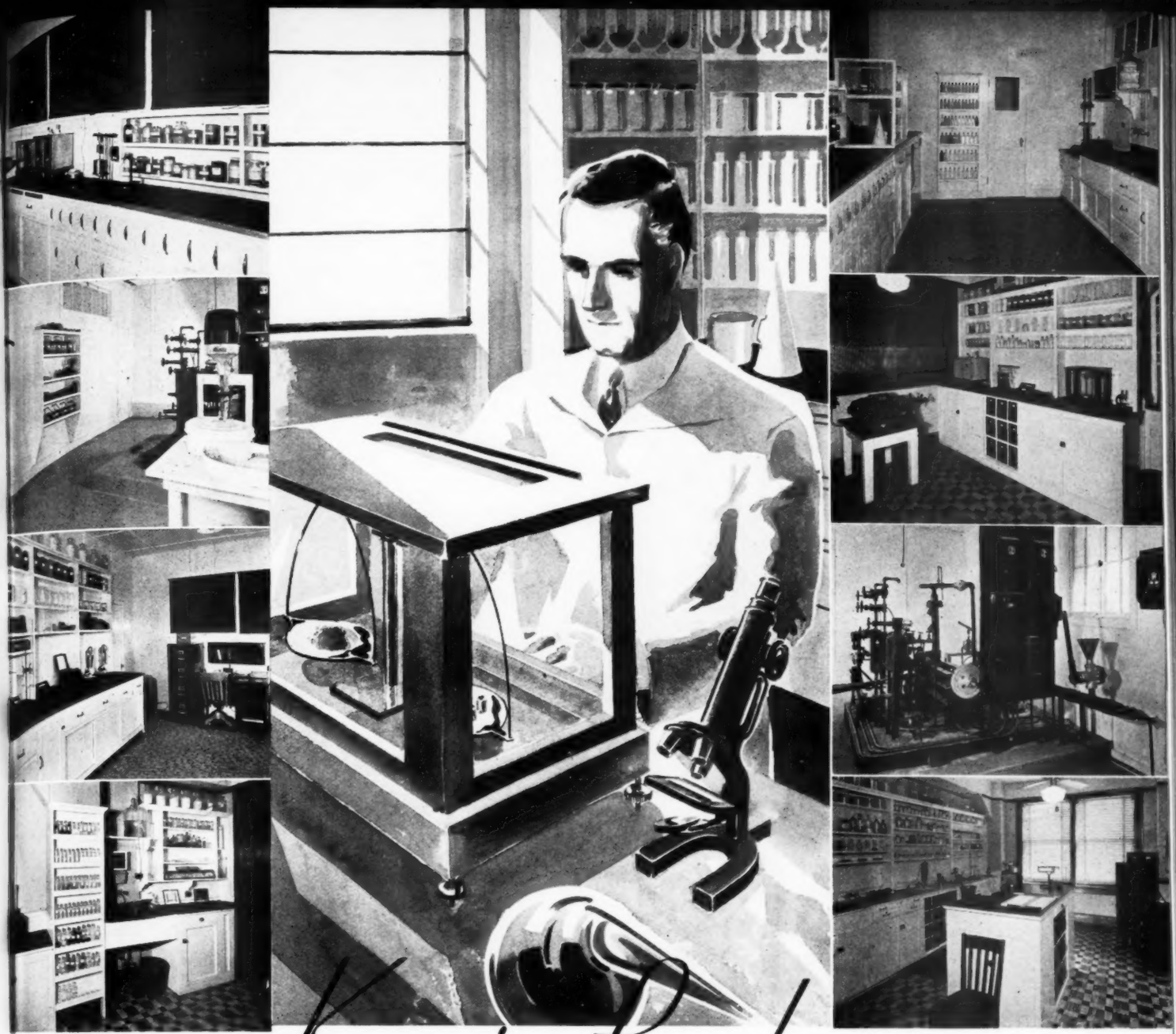
FLANGE END



MacClatchie "Hydro-Seal" Plug Valves are made in working pressures from 250 lbs. to 3000 lbs. They are made in screw, flange, and union ends, hand or gear operated.

Write for our Plug Valve Catalog

IT'S ALL IN THE LIPS



Knowing Pays!

CONSTANT research in completely-equipped laboratories at Los Angeles and Houston is responsible in a large measure for the unrivaled performance of BAROID, AQUAGEL, STABILITE and BAROCO in the field. From test tubes and modern scientific instruments our Chemical Engineers draw the hidden physical secrets of drilling muds; from years of experience with all kinds of drilling conditions, our Service Engineers apply this valuable information to the solution of *your* drilling mud problems.

KNOWING PAYS! The conditioning of drilling muds is too important to leave to guess-work. BAROID, AQUAGEL, STABILITE and BAROCO save thousands of dollars annually for operators because the benefits of laboratory research are reflected in their manufacture and application in the field.

Always use BAROID, AQUAGEL, STABILITE and BAROCO—the *proven* mud conditioners that have set new standards in quicker, safer, more economical drilling!

Stocks carried and service men available wherever there is drilling. (BAROCO in Mid-Continent and Gulf Coast only.)

BAROID SALES CO.

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Fig. 2. Shallow gas well in "shoestring" pool, Eastern Kansas. Simple screw-type wellhead connection with drip at right, serving as water trap

Redrilling and Cleaning-Out Operations in Shallow "Shoestring" Pools . . . Eastern Kansas

Many shallow oil and gas wells that were idle have been reconditioned and placed back on production

By FRANK B. TAYLOR

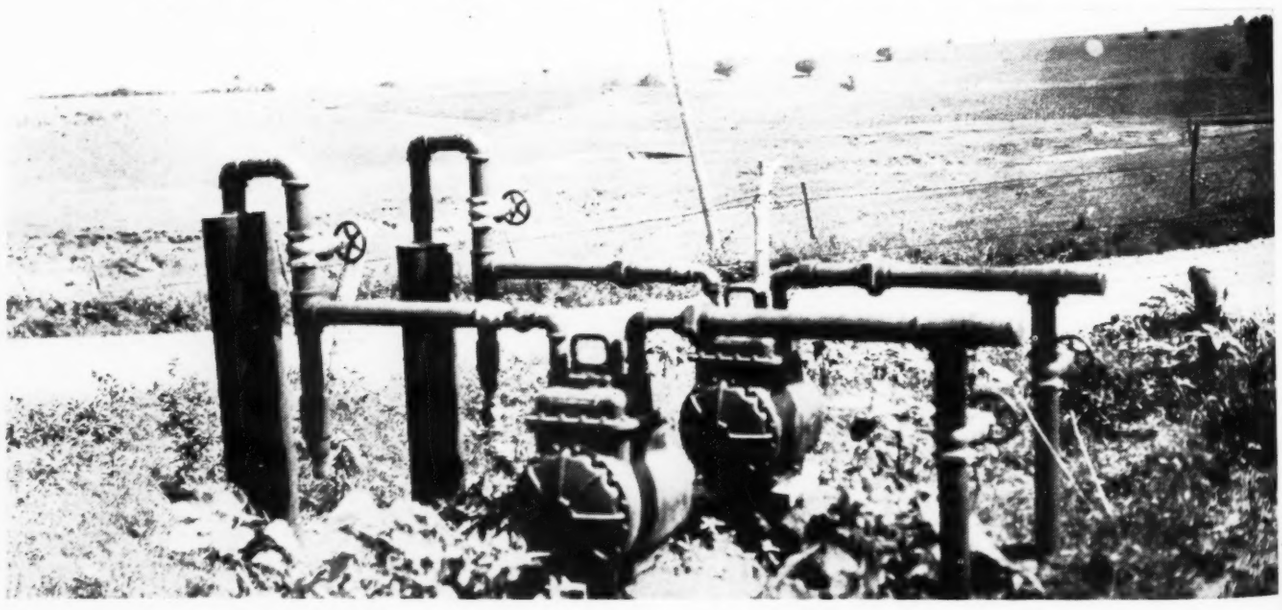
INCREASED demand for oil in Eastern Kansas has strengthened the position for this so-called "shoestring area." Although to date the return of activity has been most noticeable in the reconditioning of older wells, some of the shallow prospects have been the scene of recent drilling operations. Naturally, the usual number of unsuccessful attempts have been experienced; however, as the area has long been one definitely attractive to the small investor, or the small company attempting to gain a foothold in the oil or gas industries, additional new development may be expected. Being a section easily drilled, some unusually low completion costs have been realized. Clean-out methods and the manner of handling gas and oil production are interesting features of the area.

West, in the Eureka district, production is found at a depth of approximately 2000 ft., but east and north, the counties of Wyandotte, Johnson, Miami, Linn, Anderson, and Franklin, as well as the adjacent districts, find the pay at a depth of less than 800 feet. Western Missouri, where the same producing horizons are found at an even shallower depth, has a considerable number of the "shoestring" developments.

Most of the oil produced is obtained from narrow, winding pools, a single location in width, and from 100 yards up to four or five miles in length.

Unlike the oil, gas is more widespread in its occurrence in the area. The gas sands are at varying depths and in eastern Miami County may be encountered at 42 ft., 83 ft., 122 ft., 240 ft., and from 370 ft. to 400 ft., with another sand im-

Fig. 1. This dual setting of gathering line meters capable of passing 1000 cu. ft. per hr. each has been found satisfactory for the measurement of small gas volumes from well to gathering line. Vertical drips at the left.



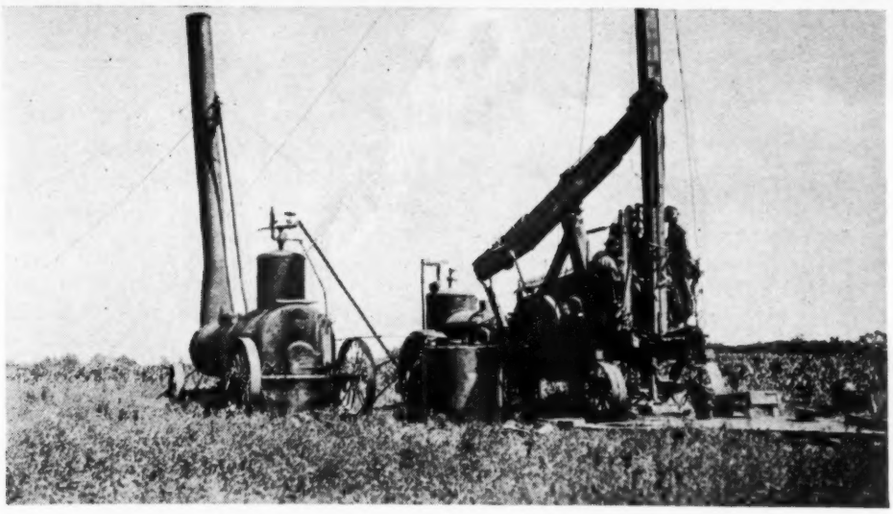


Fig. 3. Type of equipment used for reconditioning wells in the shallow "shoestring" pools, Miami County, Eastern Kansas. Coal is used to fire the boiler

mediately above the Mississippi, locally referred to as the "Big Lime." Two breaks near the top of the "Big Lime" have been penetrated in a few instances, but with few exceptions they have been found unproductive. Oil production is most prolific in the two sands above the lime. Though the possibilities of deeper production have not been condemned in the area, tests have been few.

Gas

The relatively small volume of gas production from the wells has been a hindrance to general gas development. Some companies have been formed locally to supply the regional towns and a portion of the gas is taken by major distributors. Due to water difficulties the gas wells must be produced at a fraction of their potential in order to prolong their life.

Initial rock pressures seldom exceed 150 lb., and usually drop to 50 lb. or lower if produced conservatively for six months. This limited production has resulted in the setting of positive meters for gas measurement, either in single or double settings. In Fig. 1 is shown a dual setting of gathering line meters capable of passing 1000 cu. ft. per hr. each. The water and condensate produced are cared for in the vertical type drip.

Casinghead connections on gas wells are of the open type, as shown in Fig. 2. To prevent freezing casinghead connections and the adjacent drip must be covered during winter months. Straw is used as an effective insulator.

The gas of this area is sweet, with a relatively high B.t.u. content. Wells having no pipe line connections supply farms through small regulators. In Kansas City, Missouri, numerous wells have been drilled on city lots for the owners' use. It is questionable if these are economical when the labor necessary to their proper care is considered.

Oil

Many of the "shoestring" oil pools that were steadily productive in former years, but were shut down as the price of crude dropped, have again become active. When activity was resumed it was found necessary to install new casing in a number of wells that had been idle for three or more years, on account of the corrosive properties of the water.

This reconditioning has been accomplished with a spudding machine, new pipe being driven, and where required the exposed face of the producing sand is cleaned. The latter operation has been successfully and easily done by means of a bit through which a short piece of cable is strung. With the cable frayed at either end, the wells are scraped free of any deposit, which is subsequently removed by leading. Figs. 3 and 4 show a typical setup of this equipment, using a coal-fired boiler.

Production is obtained by pumping jack, with lease tanks as storage. Pipe line facilities are scattered and the crude must be hauled from most locations.

The oil varies from 24 to 29 deg. A.P.I. gravity and is mostly of an asphaltic base; however, about three miles east of Louisburg, Miami County, some 36-gravity paraffin-base oil has been produced from a depth of 365 feet. The average depth from which oil is produced in these shoestring pools is from the sands below 200 feet. Initial production generally does not exceed 75 bbl. per day, the average being considerably less. Light shooting of wells has been successful but the danger of bringing in water has discouraged the practice; in the case of gas, shooting has been found entirely unsatisfactory.

Within recent months some gas producers have been drilled in Franklin County, reported producing approximately one-half million cu. ft. per day. New oil wells have been drilled throughout the area. The development has generally strengthened this stable "shoestring" supply, and has made it apparent that the shallow production of East Kansas, particularly insofar as oil is concerned, is coming back.

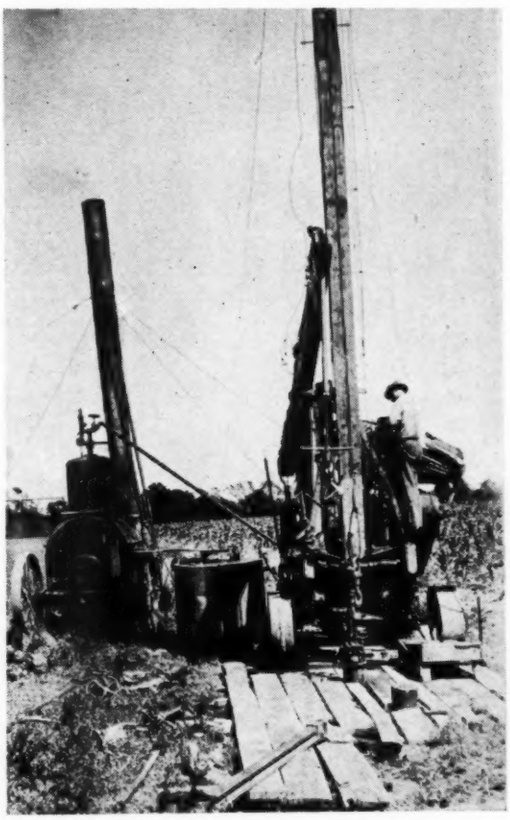


Fig. 4. Preparing to clean the sand face of a shallow oil well in the "shoestring" area of Eastern Kansas

Crane Appoints New Advertising Manager

Crane Company, Chicago, announces the appointment of H. H. Simmons as its new advertising manager. In co-operation with other aids to selling, such as exhibits, dealer service, special campaigns, and sales training, he will develop the advertising service so that it can be fitted into the general sales promotional program, it is announced. To take up his new responsibility, Simmons terminates a nine year association with Russell T. Gray, Inc., Chicago advertising agency, of which he has been vice-president and account executive.

H. H. SIMMONS

Simmons goes to his new position with a broad training in advertising, particularly in the industrial field. After graduating from the University of Illinois in civil engineering, he spent the first years of his business life in the trade publication field, serving successively as associate editor, advertising representative, and business manager. His more recent activity has been in the advertising agency field, both on general accounts and in specialized service to industrial advertisers. Among the markets he has had opportunity to study intensively are power plant, oil and gas, railroad, chemical, food, municipal, and construction.

Houston Oil Show Planning for Foreign Visitors

With the increased demand for American tools and machinery indicating the probability of a large export market for oil equipment during the coming year, the Oil Equipment and Engineering Exposition is taking definite steps to aid in the selection of American products by foreign oil companies. Representatives of oil companies from all parts of the world are being sent individual invitations to visit the Oil Show in Houston, Texas, April 20 to 25, 1936, where they will be able to study each piece of equipment thoroughly and will have an opportunity of seeing the tools and machinery in actual operation under field conditions.

Among the foreign oil men who are now planning to attend the seventh annual Oil Equipment and Engineering Exposition are the following: E. J. Daly, secretary, American Club, Yenangyaung, Upper Burmah, India; John W. Klimkiewicz, petroleum engineer, S. A. Pionier Company, Truskawiec, Poland; J. A. Higgins, engineer, International Petroleum Company, Negritos via Talara, Peru, South America; R. Kost, general drilling superintendent, Astra-Romana, Campina, Roumania; M. M. Hess, president, Hughton Oil Company, Hughton, Saskatchewan, Canada; Dave Credille, managing director, Anglo Alberta Oils, Ltd., Wainwright, Alberta, Canada; L. Steiner, Dipl. Ing., Berlin, Germany; I. I. Titarenko, chief engineer, Grozneft, Gasoline Department, Grozny, U. S. S. R.; H. R. Gilbert, tool pusher, Standard Oil Company, Prov. de Salta, Argentina; F. R. S. Henson, senior subsurface geologist, Iraq Petroleum Company, Ltd., Kirkuk, Iraq; Richard Nisbet, assistant field superintendent, Burmah Oil Company, Yenangyaung, Upper Burmah, India; Mario A. Lavarello, division contractor, Yacimientos Petroliferos Fiscales, Buenos Aires, Argentina; Dipl. Ing. C. Szabados, indus. representative, Bucharest, Roumania; Madanmohan Jain, Madanmohan Jain and Sons, Bombay, India. Many additional men have expressed their intentions of attending the show and spending considerable time in the study of methods in the Gulf Coast region.

The management of the Oil Equipment and Engineering Exposition is making arrangements for the housing and entertainment of all foreign oil men. Every effort will be made to see that they contact the manufacturers (or their representatives) of all types of equipment in which they are interested. Special plane service from South American headquarters to Houston will be arranged for while the Oil Show is in progress so that considerable traveling time can be eliminated.

Pittsburgh Equitable Adds to Research Staff

In keeping with the company policy of furthering its service to the petroleum industry through technical research, the Pittsburgh Equitable Meter Company has added two new members to the research and product development section of its engineering department at Pittsburgh.

E. M. CLORAN

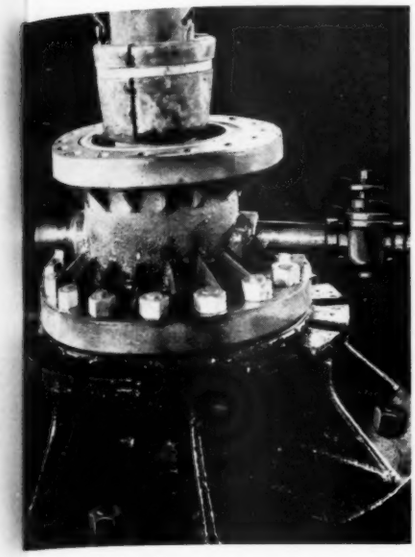
E. M. Cloran, who was graduated from Harvard University in 1928 with a Bachelor of Science Degree in engineering, comes to his new position with a valuable background of practical engineering experience. First employed following graduation from college by Stone and Webster Corporation of Boston as a junior engineer, he advanced by successive steps to become a plant engineer for the Atmospheric Nitrogen Corporation of Hopewell, Virginia, and more recently held a sales engineering position with the Consolidated Ashcroft Hancock Corporation of Bridgeport, Connecticut.

H. J. EVANS

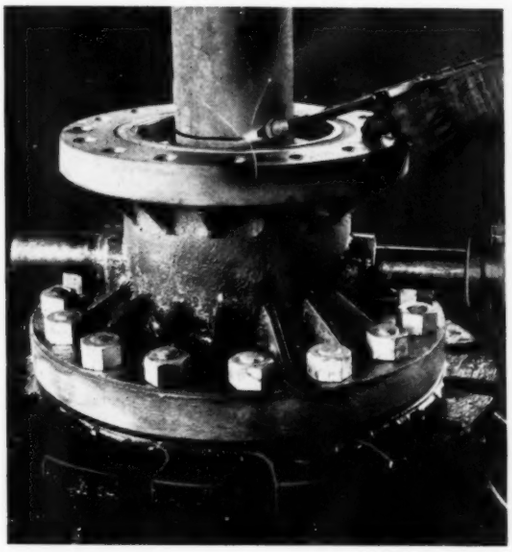
H. J. Evans is a University of Oklahoma man who was graduated with a Bachelor of Science Degree in mechanical engineering in 1933. Returning to school the following year he took post graduate work in petroleum engineering for which he was awarded a Masters Degree. Since graduation he has been employed by the geological department of the Carter Oil Company and Humble Oil and Refining Company.

Cloran and Evans will work in the physical laboratories of this company in Pittsburgh under the direction of Chief Engineer Allen D. MacLean and the immediate supervision of Research Head L. M. Van der Pyl.

Land your casing
THE FAST SIMPLE WAY..
WITH THE SHAFFER SPOOL TYPE LANDING HEAD



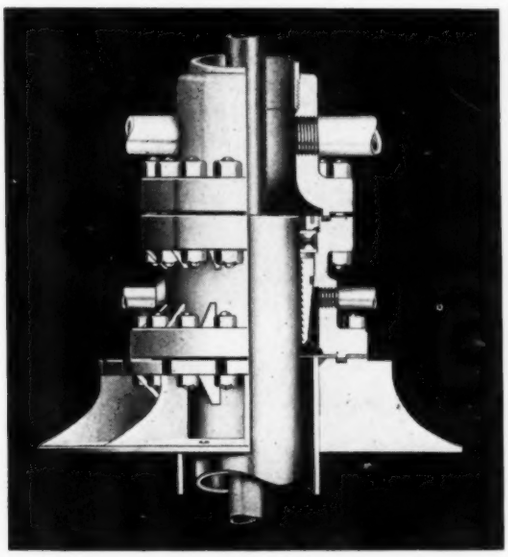
1 After the casing is run in the hole and is ready for landing, take stretch if required and insert self-aligning slips which seat in the tapered bowl of landing head.



2 The casing is cut off with cutting torch flush with top of the landing head.

3 Casing has been cut off and is ready for packing off.

4 The packing unit consisting of two split rings, rubber packing and a compression nut is placed around the casing above the slips. The compression nut is screwed tight with spanner wrench to tighten the packing.



5 Drilling connections are flanged to top of landing head in preparation for drilling for succeeding strings of casing or casing need not be cut off at the time of setting and drilling connections may be attached directly to the casing landed in the slips and extending above the head.

6 Thus the casing is quickly landed, cut off and packed avoiding the trouble, risk and delay of "letting go" casing, running a holding tool, unscrewing the top joint (which may strip the thread) sending to the nearest available shop to have nipple cut, making up nipple in a dropped string and connecting the string with the head.

Other Advantages of The Shaffer Spool Type Landing Head Are:

(A) Each individual string is landed with safety at any point desired without any necessity for "letting go", measuring or re-threading.

(B) Each string is supported on its own flange with an upper flange provided for the support of the next string.

(C) Each string is suspended on its own set of slips with no accumulation of weight put on those slips by subsequent strings of casing and tubing.

(D) Each string is packed off securely against high pressure with provision for gas outlet, mud line or overflow as required.

SHAFFER TOOL WORKS

BREA, CALIFORNIA — HOUSTON, TEXAS. EXPORT, OIL WELL SUPPLY COMPANY

Engineering Fundamentals Department

- A Study Course for Field and Plant Men
- A Review for Experienced Engineers

W. L. NELSON
K. C. SCLATER
Editors

Elements of Applied Petroleum Production

By K. C. SCLATER

Article 26

CLEANING-OUT AND REPAIRING WELLS—(Concluded)

CLEANING-OUT practice in the fields of the Gulf Coast is greatly influenced by the conditions obtaining there. Screens are used in this area almost exclusively. Usually when a well has to be cleaned out or reconditioned the screen has to be pulled. In many of the old wells where the pressure is low there is always danger of mudding-off the sand during this operation. To prevent this, oil or oil-base mud is sometimes used in the hole while pulling the screen.[101]

The mud is weighted according to the bottom-hole pressure. By using this so-called oil-base mud its lighter weight reduces the hydrostatic pressure at the bottom of the hole, thus decreasing the hazard of mudding-off the face of the sand. These oil-base muds have no free water. After the screen is pulled an underreamer is run to remove the old face of the sand. The hole is then washed to bottom with a bit and the screen renewed or replaced.

The common method of reconditioning wells in California is by bailing and swabbing. Hydraulic suction-type bailers are now widely used for this purpose. These obviate the necessity in many cases for using tools in cleaning-out. This same type of bailer with side-ports is used to clean-out perforations in pipe. Electromagnets are also employed to remove pieces of steel that cannot be recovered by the bailer.

Washing of the perforations is a method commonly employed to increase the production of wells. For this purpose there are two types of tool, the suction type and the pressure type.[102] In the pressure type the fluid is forced outward through the perforations. With the suction type the silt or sand is pulled from the perforations into the perforation-cleaning tool.

Methods of overcoming water troubles in wells in California are of the most advanced type. Steps are taken first of all to determine the source of water entering the well. For this purpose determinations are made by most accurate methods. An electric tool, run into the hole on an insulated cable, measures the resistance of the fluid in the hole to the passage of an electric current between two electrodes.[102, 103] When this method is used to detect the entry of water, the hole is first conditioned "by running the tubing to bottom and circulating fresh water until all other fluid has been replaced. The tubing is then pulled up into the blank casing above the top of the perforations or to a point where water is suspected of entering. The instrument is run into the hole to check the conditioning, and then the well is bailed or swabbed to its normal fluid level, whereupon the instrument is run again. Bailing or swabbing is continued for the purpose of lowering the fluid level by stages; between each bailing operation the instrument is again run until the water source has been located. Since fresh water has a very high resistance, and salt water a much lower one, the point of entry of the salt water is determined by an indicated lowered resistance.

"The voltaic method converts the hole into a galvanic cell by placing an electrolyte, consisting of rotary gel, water, and an acid, in that portion of the hole which is to be tested. After conditioning, the procedure outlined above is followed to break the salt water into the hole. This method is based on the measurement of the potential established between the electrodes by the solution placed in the well. The source of the water is detected by a lowering of the potential induced by dilution of the electrolyte at the point of entry.

"After water-location tests have located the entry horizons —which can be referred to definite markers—salt-content tests have proved effective in some fields for determining entry points in other wells — without recourse to further electric testing. Interpretation of the data obtained by the above methods has improved to such an extent that the exclusion of water has been greatly simplified."[102]

When it is desired to remove the liner or the oil string to repair the well the usual procedure is as follows: The liner is removed by inside washing and jarring. "The liner is cleaned out to bottom, and the perforations are washed with a pressure-type washer using oil as a circulating fluid. To

insure efficient operation of the washer, it may be tested against pressure by being set in the upper blank portion of the liner. The washing should be done in stages, starting from the bottom. A string of fishing tools—consisting of a releasing spear, safety joint, jars, and two or more heavy drill collars—is run, the spear being engaged in the top of the blank section of the liner, and jarring commenced—the force of the jarring action being governed by the mechanical condition of the well and equipment. Jarring is seldom continued for more than two hours—after which the spear is released and removed from the hole. The well is bailed to remove the sand that may have entered the liner as a result of vibration, and the perforations are re-washed before jarring is resumed. In the case of a full oil string which cannot be removed by direct pulling at the surface, a cut can be made not lower than ten ft. above the shoe of the water string, and the casing pulled from that depth. Thereafter the procedure is the same as for a liner.

"When it has been found impossible to remove the perforated casing by the above method, it may be cut and removed in sections by the use of an inside casing cutter. The first cut is usually made at the bottom of the blank casing, provided this point is at least ten ft. above or below the shoe of the water string—as a matter of precaution—so that it will be possible either to enter or wash over the liner. It is customary to make at least three cuts while the cutter is in the hole—the length of each cut depending on the ease of removal, the length of liner, and the field conditions. The cuts should be made immediately below collars, because a greater choice of fishing tools is thus permitted, and the hazard of washing over is lessened.

"When it is impossible to remove the perforated casing by the above method, it may be washed over, cut, and removed —provided the size of casings will permit of such operation. For ease in handling, the wash-over string should be equipped with special tool joints. Good practice limits the maximum length to 150 ft., because of the danger caused by inside and outside friction. It is preferable to use long joints on the wash-over pipe to reduce the number of couplings. The hazard of running a wash-over string is materially reduced by using a safety joint and rotary jars of the drilling type immediately above the string."

"By this method the liner is removed by alternate runs of the wash pipe and outside casing cutter, which removes each section of liner after cutting it. The use of a knuckle joint—consisting of a short length of wash pipe and an outside casing cutter with a spiral guide on the bottom—permits the making of a short cut, even though the casing may be in such a position that it is impossible to wash over with the usual type of string. Other special assemblies are also used to overcome similar difficulties, such as inside cutters, or wash pipes equipped with smaller protruding internal guides. After the liner has been recovered, a bit or wall scraper should be run to clean the walls preparatory to cementing."

"After the point of water entry has been located, the decision must be reached as to whether the liner or oil string should be removed prior to repair. Where such removal is not practical, water may be excluded in many cases by plugging with cement through the perforated casing. The success of such cementing operations depends on forcing the cement through the perforations to obtain a mechanically-tight seal with the formation. Prior to plugging, the perforated casing may be washed, re-perforated, or, in the case of bottom water, shot, so that suitable openings will be made to expose the formation and assist in obtaining the proper bond."[102]

Equipment for cleaning-out wells is of two general types: permanent and portable. Up until recent years the portable type of equipment was used only for shallow wells. Today portable equipment is available for cleaning-out wells of almost any depth, so great have been the advances made in design.[104] Of the permanent equipment there are several makes. These are employed for both pumping and pulling. The common type is the regular standard cable-tool equipment, driven by gas or steam engine, through a bandwheel transmission. The calf-wheel, driven through a sprocket in the bandwheel, is used in pulling operations. The bull-wheel is used if tools are employed for cleaning-out. Sometimes special hoists are used in place of the calf-wheel. Between the prime mover and the hoist, pulleys are used to reduce the speed, a reduction being made between the engine and bandwheel, and the bandwheel and hoist. The sand line is used for bailing or swabbing. This type of rig is gradually being supplanted by rigs of more modern design that have greater pulling speeds, time being an important element in cleaning-out operations.

Most of the pulling and pumping equipment being installed today is of the high-speed type, driven by gas engine or electric motor through reduction gears or chains and sprockets.

Portable equipment units for cleaning-out wells are usually mounted on tractors, on trucks, or on trailers. These machines are available for almost all depths of wells. The trend today is toward this type of equipment for cleaning-out operations. One unit can be used to service a number of wells. The pumping equipment can be made to closer power requirements and the investment per well thereby greatly reduced. This factor of economy has been an important one in extending the use of this type equipment.

Such cleaning-out units today are quite complete and are designed for suitable hoisting speeds at all loads. Being designed especially for pulling service such as involved in cleaning-out operations, they are economical. Their great flexibility is another feature. Maintenance costs are usually low and since each unit is capable of servicing a number of wells, the overall maintenance costs are reduced.

QUESTIONS

1. What is the purpose of an oil-base mud as used in the Gulf Coast while reconditioning wells?
2. Describe the method of locating the entry of water in wells by electric means as used in California.
3. Describe methods used in California to remove a liner or oil string preparatory to repairing the well.
4. Describe the different types of equipment that you have observed in the field for cleaning out and repairing wells.

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[102]"Reconditioning of Oil Wells in California," by W. C. Whaley, A.P.I. Production Bulletin 212.

[103]"Locating Water Entry in a California Well," *The Petroleum Engineer*, p. 138, March, 1931.

[104]"Reconditioning of Wells in the Oklahoma City Field," by C. E. Wright, A.P.I. Production Bulletin 212.

Elements of Applied Petroleum Pipe Line Transportation

By C. E. MAIN, SR.
Engineer, Sinclair-Prairie Pipe Line Company

Article 17

FLOW OF LIQUIDS IN PIPE LINES (Part VI)

Application of the Hagen Formulae

IN this article frequent reference will be made to the first series of articles appearing in the July, August, and September, 1935, issues of *The Petroleum Engineer* where the derivations of the Hagen formulae were given together with several other useful formulae, and a table of the equivalent number of 12-in. pipes equal in carrying capacity for several diameters of pipe.

In the Hagen form of equation it is intended to have a coefficient of roughness (b) that is a constant for all diameters, velocities, and viscosities for a given kind of pipe by assigning the proper values to the exponents x, n, and w.

The Hagen formula has four unknown experimental quantities that must be determined experimentally from actual experiments taken upon the particular kind of pipe in question. Our progress since 1854 has been none too encouraging, considering the progress made especially in the construction of crude oil and gasoline pipe lines in the past 30 years.

We have, however, determined these four unknown quantities approximately, by plotting the experimental values of the Chezy ($f\mu$) against the argument B/DKN, to obtain a single line that has been assumed by most investigators to cover all diameters, velocities, and viscosities for the flow in wrought-iron and steel pipe. The slope that such a line (logarithmic plotting) makes with the axis of abscissas will give the value of $2\text{-}n$, $x\text{-}1$, and w since the exponents are related. The coefficient of roughness b is the intercept of this line on the axis of ordinates.

It is very doubtful if the flow of liquids follows the exponential law, however, since most investigators have heretofore developed their values of the Chezy friction factors; that is, the variation in ($f\mu$) due to diameter, velocity, and viscosity by logarithmic plotting, we may therefore use this exponential relation directly in the Hagen formula, and thus eliminate the necessity of a table or graph of the Chezy friction factors. Then too, the Hagen formulae are more direct in their application for both streamline and turbulent flow problems.

A typical layout of a system of parallel lines for a station district of three sections is shown diagrammatically in Fig. 5, in which there are eight 8-in. lines in the first section, three 8-in. and two 12-in. lines in the second section, and one 8-in. and three 12-in. lines in the third section.

For every computation of flow, especially in parallel line flow problems, a sketch should always be made, providing a place to enter all known and unknown values as they are determined in the various steps of the solution of the entire problem. This will not only provide an excellent plan for entering the notes, but will give a convenient record of each layout, if the computations of each sketch are attached thereto.

Such a plan will now be shown for the computations in this demonstration.

Pump pressure = 650 lb., Pump head = 1797 ft., Available friction head = 1653.8 ft., Viscosity = 98.5 SUS, k = 19.44, Observed gravity = 38.0 deg. A.P.I. at 35 deg. fahr., Equivalent diameter D = 12.00, B = 6150, M = 6.61942.

Values of the Coefficient and Exponents

In the Hagen formula such values should be assigned to the exponents x, n, and w so that the coefficient of roughness b is not influenced by, but is independent of, the diameter, velocity, and viscosity. These values have never been definitely determined from experiments upon single line flow; however, many conflicting sets of values have been proposed for both related and unrelated exponents, but in most instances only x and n were considered, hence, such values of b, x, and n now quoted in the hydraulic literature are influenced by the viscosity, since the viscosity was not considered at the time the experiments were taken.

In the writer's analysis of the incomplete experiments that have thus far been published, together with several hundred of his own incomplete experiments, it was undertaken to determine independently the values of x, n, and w, then collectively by the Chezy ($f\mu$)—Argument method on the Stokes logarithmic form of diagram. The results were not so encouraging as one would expect; however, the results of this investigation gave values of b, x, n, and w that have been used over a period of years with surprisingly close results in lines that were known to be clean.

The value of the coefficient b is greatly affected by the collection of B.S. on the inside surface of the pipe. For this reason, experiments should only be taken upon lines that have just been cleaned.

In the application of the formulae that follow, the writer will use his own value of b and of the exponents x, n, and w, which are:

$$b = 0.018168 \qquad x = 1.25$$
$$n = 1.75 \qquad w = 0.25$$
$$(2n + x/n) = 2.714 = 19/7 = m \qquad (2n + x) = s = 4.75$$

and they are used for turbulent flow when the value of the argument B/DKN is above 53.

Equivalent Number of Lines of a Given Diameter

In a station district composed of two or more sections of piping, where each section has more than one size of pipe, or a different number of lines, it is necessary to know the equivalent number of lines of a chosen diameter in each section in order to reduce the computations to a basis of the equivalent discharge B^n/N^n of one line of the chosen diameter for the actual length separately for each section, or to the basis of M/N^n the equivalent length of a single line of the chosen diameter for the entire district, having the same discharge and friction head.

Equation 10 (p. 80, August issue) or Table 1 (p. 93, September issue) column 6, may be used in determining the

Average of 54 welds per welder per day was made on this 8-in. pipe line. Insert shows close-up of Multi-Flame Lindeweld Head in action.

Multi-Flame LINDEWELDING *again breaks* pipe line records

TWELVE and three-quarter days after the first Multi-Flame Lindeweld was made, the 20 miles of 8-in. pipe line for a large company were completely welded, setting another record for fast production.

The results obtained were, in a sense, remarkable as most of the pipe was torch-beveled and in short lengths of about 20 ft. Notwithstanding this condition, Multi-Flame Lindewelding came through with an average record of 54 welds per welder per 8-hr. day. One day two welders reached the peak of 121 welds, or better than 60 per man.

Pipe line officials were more than pleased with the results obtained with Multi-Flame Lindewelding and the cooperation of Linde engineers during the construction of the line.

Multi-Flame Lindewelding is a new method of oxy-acetylene welding developed by the Linde engineering and research organizations. It involves a special flame adjustment, the Oxweld No. 24 Lindeweld Process Welding Rod, and the new Multi-Flame Lindewelding Head. Lindewelding is consistently saving 15 to 40 per cent in welding time, rods, and gases.

You can secure complete information on Multi-Flame Lindewelding from Linde Offices located in thirty principal cities throughout the country and at 30 East 42nd Street, New York, N.Y. The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation.

Everything for Oxy-Acetylene Welding and Cutting

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number of 12-in. lines equivalent to an 8-in. line, taking the 12-in. size as the chosen diameter. By either route 0.33055 line 12-in. diameter equals one line 8-in. diameter, from which the equivalent number of 12-in. lines are computed for each of the three sections as follows:

SECTION 1

8 lines 8-in. dia. $= 8 \times 0.33055 = 2.6444$ lines 12-in. dia.

SECTION 2

3 lines 8-in. dia. $= 3 \times 0.33055 = 0.99165$ lines 12-in. dia.
2 lines 12-in. dia. $= 2 \times 1.00 = 2.00$ lines 12-in. dia.
Total of 2.99165 lines 12-in. dia.

SECTION 3

1 line 8-in. dia. $= 1 \times 0.33055 = 0.33055$ lines 12-in. dia.
3 lines 12-in. dia. $= 3 \times 1.00 = 3.00$ lines 12-in. dia.
Total of 3.33055 lines 12-in. dia.

Enter the three equivalent number of 12-in. lines in their proper positions in the aforementioned sketch.

Equivalent Length of Each Section

It has been shown (p. 80, August issue) that Equation 8 will give the equivalent length of a section of the chosen diameter that will consume the same friction head for a given discharge, as the actual lines would for their actual length for use in the Hagen formula.

Equation 8 for each of the three sections of the station district will give for the equivalent lengths of each section:

SECTION 1

$$M_1 = \frac{15}{2.6444^{1.75}} = 2.73539 \text{ miles}$$

SECTION 2

$$M_2 = \frac{14}{2.99165^{1.75}} = 2.05724 \text{ miles}$$

SECTION 3

$$M_3 = \frac{15}{3.33055^{1.75}} = 1.82679 \text{ miles}$$

Each should be shown in its proper place in the aforementioned sketch.

The writer wishes to call particular attention to the fact that in the computations of the equivalent length of each section, Equation 8 was used because these results are to be used in the Hagen formula. If they were to be used in the Chezy formula, or in any adaptation thereof, then Equation 14 (p. 91, September issue) would have been used. This distinction should be clearly understood as it was not apparent in a recent article published dealing with parallel line flow.

Equivalent Length of the Station District

These equivalent lengths of each section for one 12-in. line may be added together for the total equivalent length of the entire station district as was demonstrated by equation No. 17 (p. 92, September issue).

We now have:

$$2.73539 + 2.05724 + 1.82679 = 6.61942 \text{ miles}$$

as the equivalent length of one 12-in. line that will consume the same friction head for a given discharge as the layout shown in Fig. 5. This is one of the values required in the discharge formula.

A.P.I. Gravity of the Liquid

A 40.0-deg. A.P.I. true gravity oil at 60 deg. fahr. is to be pumped when its temperature is at 35 deg. fahrenheit. The observed gravity of this oil when it is at 35 deg. fahr., may be obtained from the A.P.I. gravity table in the Tag Manual or in a much simpler manner from the Vanderveer Gravity-Temperature graph. The corresponding observed gravity for a temperature of 35 deg. fahr. is found to be 38.0 degrees.

Pump Head in Feet of Liquid

If station A is to operate at a maximum pump pressure of 650 lb. per sq. in., pumping a 38.0 observed gravity crude at 35 deg. fahr., the corresponding pump head in feet of the liquid being pumped is obtained by Equation 6, in which:

$$h = \frac{(131.5 + 38.0)\ 650}{61.287} = 1797 \text{ ft.}$$

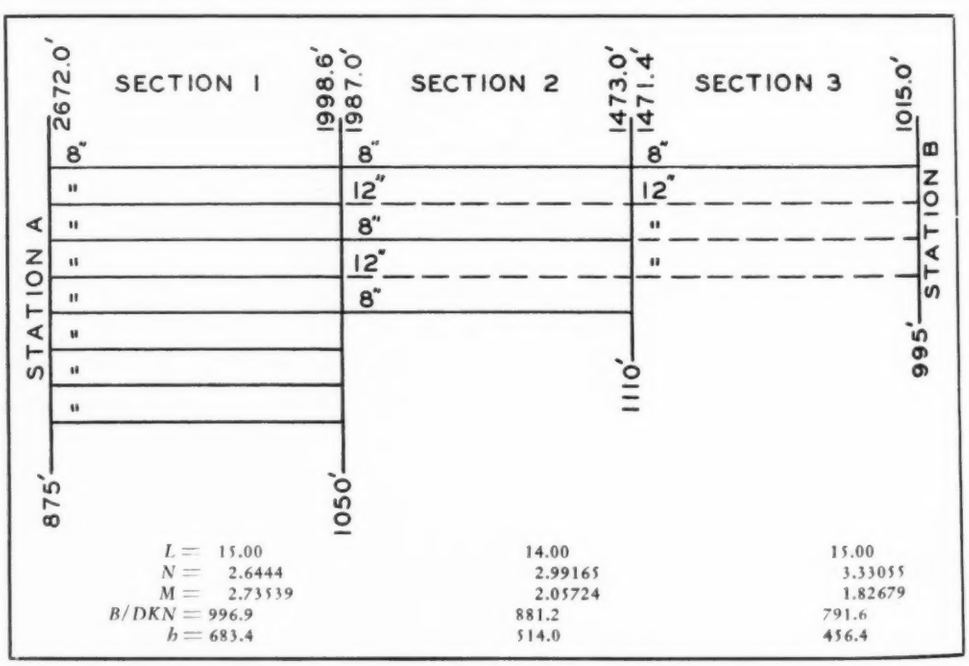

Fig. 5. Diagram for a typical layout of a system of parallel lines for a station district of three sections, in which there are eight 8-in. lines in Section 1, three 8-in. and two 12-in. in Section 2, and one 8-in. and three 12-in. lines in Section 3

Nativity

Is there a birthday, e'er so dear,
Whose dawn on each succeeding year
Brings not a twinge, perhaps a tear?
Yea, there is One!

Is there a birthday we attend,
Whose gayety does not extend
Life's vivid pattern toward the end?
Yea, there is One!

Oh, what a birthday to embrace,
That would arrest our desperate pace
And hold as naught all time and space!
But there is One!

Hail! Hail the day that we
May honor Christ, the Lord, and be
Returnèd to Nativity!

W. E.

Written and illustrated especially for the

Gaso Pump & Burner Mfg. Company

Tulsa, Oklahoma

Elements of Applied Petroleum Refining

By W. L. NELSON
Consultant*

Article XXVI

PRACTICE OF CRACKING

THE commercial practice of cracking is much the same in all types of cracking processes. The equipment that is used and the arrangement of the equipment differs from process to process but essentially the same operations are conducted in all of them.

Modern cracking processes must be able to produce a large amount of gasoline, produce little coke, and be able to operate for a long period of time before shutting down for cleaning. The percentage of time that the unit is in active operation is referred to as the cycle-time-efficiency. Thus, if the unit operates for nine days, and one day is required for cleaning, the cycle-time-efficiency is 90 percent. Most successful plants have a cycle-time-efficiency exceeding 93 percent unless coke is being produced and in such a case the efficiency may be as low as 60 percent.

PRINCIPLES OF PROCESSING. In obtaining a high cycle-efficiency and a large yield of gasoline, several principles of operation have been carefully tested in commercial experience and have been found to be advantageous. The most important of these are:

1. The use of a high recycle ratio or a large amount of recycle stock.
2. The use of a clean stock or even a distilled stock as the charge material.
3. The practice of quenching or quickly cooling the hot stock that issues from the cracking pipestill so that localized over-cracking can be avoided.
4. The production of a homogenous phase, that is: either a pure liquid-phase, a pure vapor-phase, or a very dense mixed-phase, in the zone in which cracking occurs.

The success of a commercial cracking process depends largely on the use of a high recycle ratio. The recycle ratio is usually defined as the amount of recycle stock divided by the amount of fresh charge stock. Thus, if a plant uses 500 bbl. per day of fresh charge, but the charge to the cracking-pipestill consists of 1000 bbl. of recycle and the 500 bbl. of fresh feed or a total of 1500 bbl. per day, the recycle ratio is two to one. The recycle ratio is intimately connected with the crack-per-pass because as the recycle ratio is increased the amount of decomposition per pass or cycle must decrease accordingly. Thus, if an ultimate yield of gasoline, based on the 500 bbl. of fresh feed is 60 percent and the recycle ratio is two to one, the crack-per-pass is 20 percent. If the recycle ratio were three to one, or a total of 2000 bbl. were charged to the pipestill each day, then the crack-per-pass would be only 15 percent.

The general effect of increasing the crack-per-pass or decreasing the recycle ratio, is somewhat as follows:

1. A lower yield of gasoline.
2. A higher octane-number product.
3. An increased tendency to produce coke.
4. The production of more gas.
5. A decreased operating cost unless the cycle-time-efficiency becomes very low.
6. A smaller capital investment.

Thus, a low crack-per-pass increases the gasoline yield,

*Professor of Petroleum Refining, University of Tulsa.

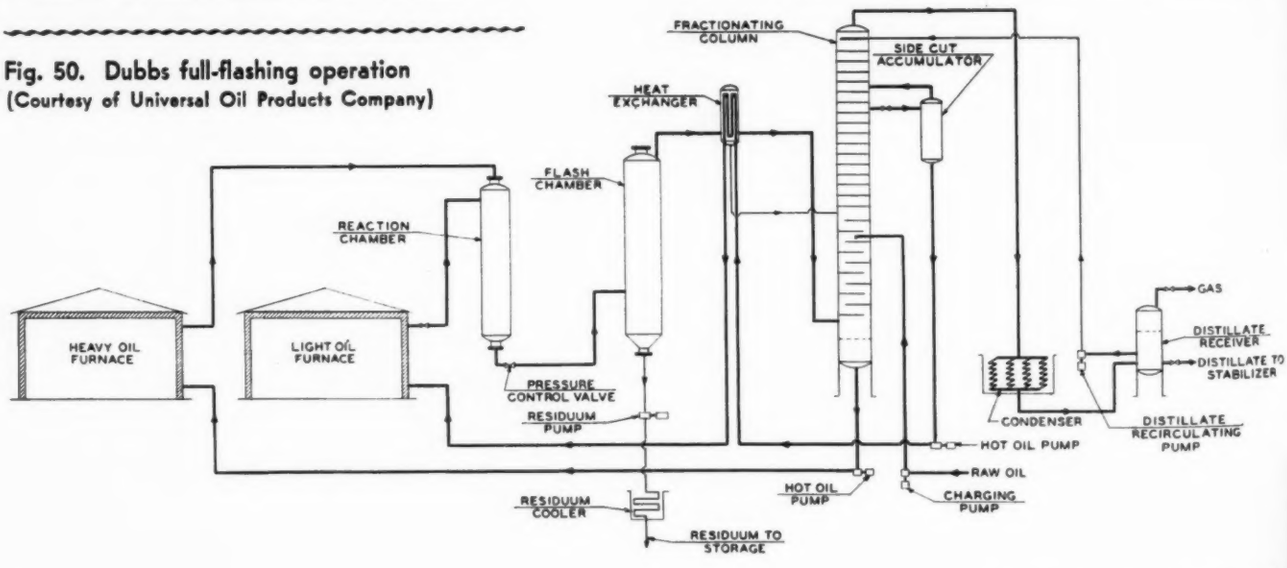

Fig. 50. Dubbs full-flashing operation
(Courtesy of Universal Oil Products Company)

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OLD but NEW

Swan Underreamers, reliable "stand-by" of cable tool operators for half a century, has been continually modernized with improvements in *patented design, better steels, scientific heat-treatment and efficient hardfacing,* making it the most modern, efficient and economical underreamer in use today.

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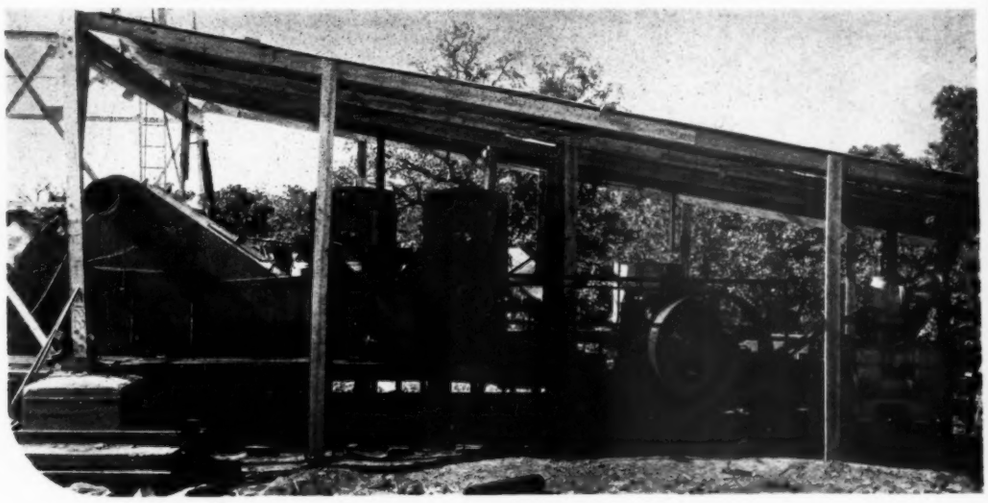
From the newest and most advanced types of drilling tools and machinery, for either rotary or cable tool work, to factory rebuilt and reconditioned used equipment, we supply the kind and type of equipment to most economically handle each particular type of work or individual project.

A telephone call to any of our stores or offices will bring you timely and dependable information on any type of equipment you may require

LATEST TYPE ROTARY DRILLING UNIT



This ROTARY DRILLING UNIT, one of the latest types for rotary work, was recently delivered by us. It consists of a Model 876 Portable Rig Co. Unit with Draw Works, Duel Engine Compounding Drive, 160 HP Waukesha-Hesselman Gas Engines and Wilson-Snyder Power Pump, with drilling tools and accessory equipment. *Specifications, prices and other details on this and similar equipment gladly furnished.*

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Supplementing our Aquagel, Baroid and Stabilite Drilling Mud service, we now supply from convenient stocks ample quantities of BAROCO, the new blended and treated drilling clay. . . BAROCO produces a 9-pound per gallon drilling mud that retains its colloidal properties in the presence of salt water. Its greater yield per ton (approximately 40 barrels per ton) makes it the most economical drilling clay available. *Comparative cost figures and other data available for interested parties.*

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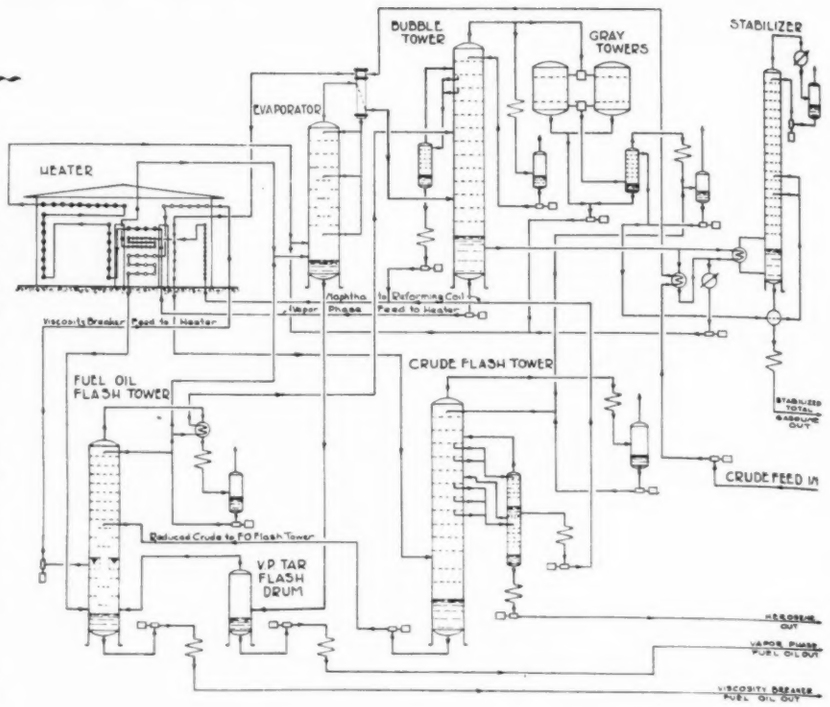
Fig. 52. Combination process
(Courtesy of Gasoline Products Company)



causes less gas formation, and avoids difficulties with coking, but the cost of the equipment is greater; the operating costs, barring coking, are greater and the octane-number of the product is lower; however, the prime concern of the plant operator is to avoid the formation of coke and frequent shut-downs, and hence, the plant should be operated at as low a recycle ratio as possible without getting into trouble with coke formation.

The recycle ratio is seldom less than two to one and more commonly it is three to one. In vapor-phase processes it may be as high as five to one. Perhaps a better means of comparison is the crack-per-pass. In mixed-phase processes the crack-per-pass ranges from 15 to 23 percent and in vapor-phase processes it may be as low as 12 percent.

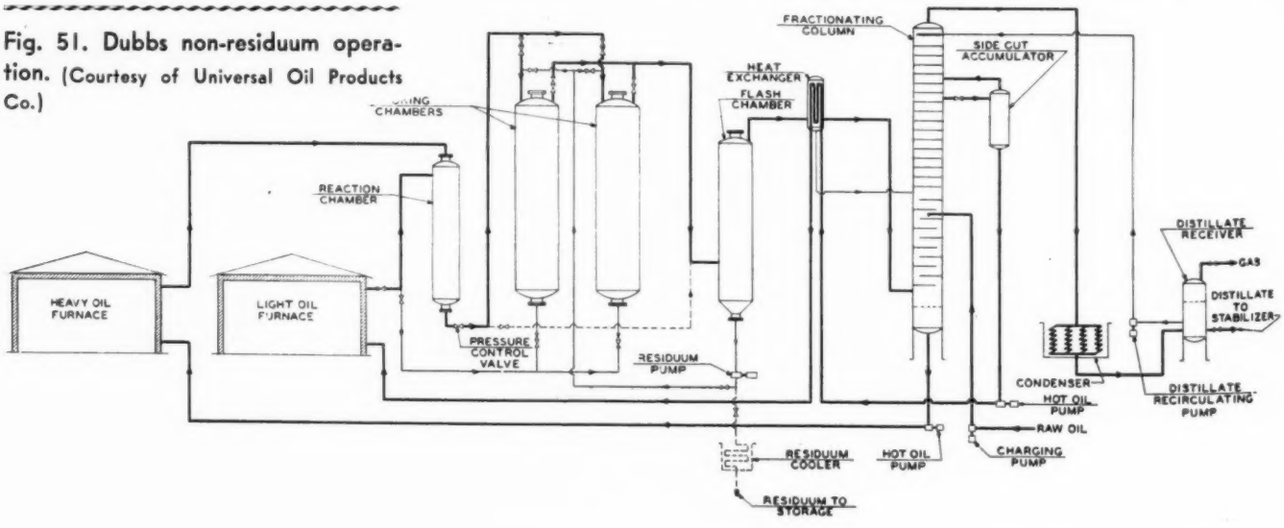
CLEAN CHARGING STOCKS. At one time it was thought that coking could not be avoided in the tubes of a cracking-pipestill without using a distilled charging stock. Now we have found that straight-run tars or black stocks can be cracked in the tubes of a pipestill without serious coking difficulties, but that even a small amount of the tar produced by cracking will cause coking. All new or modernized cracking plants are operated so that no cracked tar is exposed to cracking conditions and many plants charge only distilled stocks to the cracking-pipestill. The use of a distilled charge stock is indicated in Fig. 16, Article VI, April 1934. In this figure, the black or residual charge stock is used to cool the cracked stock from the still. In so doing it becomes heated and the gas oil that it contains is vaporized. The gas oil and recycle stock are collected together from the base of the fractionating tower and the combined distilled feed-stock is charged to the pipestill. The tar in the black charge stock and the tar produced by cracking are eliminated continuously from the base of the vaporizer or evaporater B. Much the same system is used in many modern cracking plants regardless of the name of the process. The process illustrated in Fig. 16 is often referred to as the Tubestill Process.

The cracking of a black charge stock without eliminating the tar is indicated in Fig. 50, which shows the full-flashing method of operating the Dubbs Process. The Dubbs Process is one of the few processes that can crack a black stock successfully; however, note that the cracked or polymerized tar is removed during each cycle so that none of it is exposed to cracking conditions. The cracking of a black charging stock results in slightly larger yields of gasoline but the recycle ratio must be slightly higher and excellent furnace conditions must be maintained.

QUENCHING. The earlier cracking processes operated at a relatively low temperature and used a relatively long time for cracking. In such operations the time of cracking can vary by several minutes without serious trouble but in modern high-temperature processes the time is short and it must be carefully controlled. For this reason, a so-called quenching operation must be used. The quenching is usually accomplished by means of a bath or chamber of oil that is cooled by the charge stock as in Fig. 16, or it may be cooled by a stream of reflux.

HOMOGENEOUS PHASE CONDITIONS. The de-

Fig. 51. Dubbs non-residuum operation. (Courtesy of Universal Oil Products Co.)



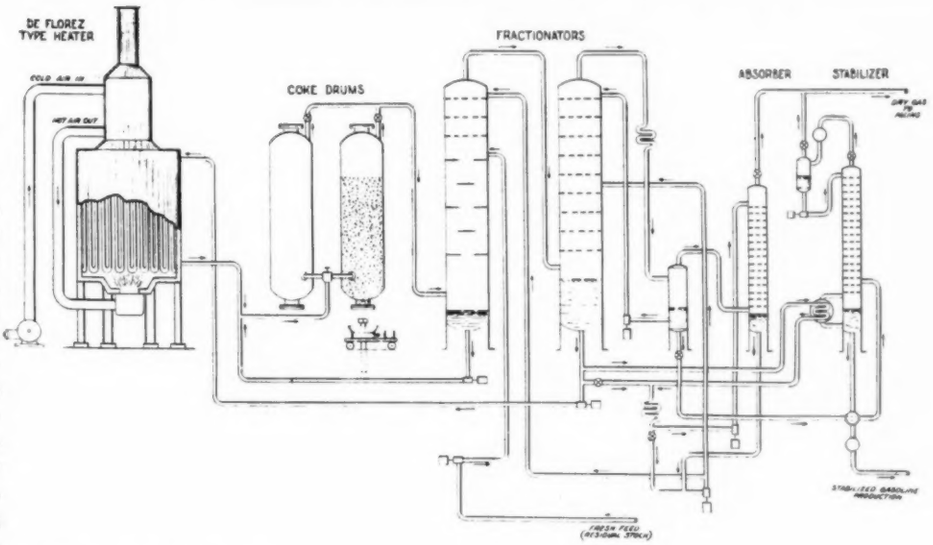


Fig. 53. De Florez coking process (Courtesy of Gasoline Products Company)

velopment of vapor-phase processes has clearly shown that a mixture of liquid and vapor that tends to separate by stratification cannot be successfully cracked. The liquid tends to collect on the heated surfaces and undergo an excessive amount of decomposition with the result that coke is deposited. In vapor-phase processes a pure vapor-phase is produced by using a relatively low pressure. If the temperature exceeds about 860 deg. fahr., a pure liquid-phase cannot be produced even by using a very high pressure because the temperature exceeds the critical temperature of the hydrocarbons and no amount of pressure will condense them; however, the cracking of a mixed-phase is successfully accomplished in most of the common cracking processes by the use of a high pressure. At a pressure that exceeds the critical pressure of the hydrocarbons that are present, the density or weight of the vapor that is produced is nearly as great as the density of the unvaporized liquid and hence little separation or stratification occurs. The pressure that must be used is at least 250 lb. per sq. in. and many mixed-phase processes operate at a pressure of 600 lb. in the cracking zone. The pressure that is used in the cracking zone should not be confused with the pressure at the pump. The pressure at the pump will be higher than the cracking pressure because of friction losses through the lines and still.

As a summary, the conditions that tend to increase the yield of gasoline may be listed as follows:

1. A low conversion-per-pass or a high recycle ratio.
2. A relatively low pressure (200-300 lb.).
3. A relatively low cracking temperature (860-900 deg. fahr.).
4. The cracking of all of a black charging stock, but care must be taken that no cracked or polymerized tar is permitted to enter the zone of cracking.

CRACKING PROCESSES

Because of the limited space that is available, all the various cracking processes cannot be discussed. As illustrative processes, the flow diagrams of the Dubbs Process of the Universal Oil Products Company (Figs. 50 and 51), the Combination Process and the DeFlorez Coking Process of the Gasoline Products Company (Figs. 52 and 53), and the Gyro Process of the Alco Products Company (Fig. 54), will be presented. The Tubestill Process has already been presented in Article VI, April 1934, of this series as Fig. 16. These processes have been selected because they are representative of the practice of cracking and not primarily because they are the best processes for all conditions.

DUBBS PROCESS. The Dubbs Process is illustrated by two types of operation, the full-flashing operation for the production of a fluid residue as shown in Fig. 50, and the non-residuum type of operation for the production of coke as shown in Fig. 51. In full-flashing operation the hot cracked stock is admitted to the top of the reaction chamber and after a soaking or reaction time in the chamber it issues from the bottom into a combined flash chamber and fractionating tower. The inverted flow probably results in a short time of cracking for the liquid part of the hot cracked stock and a longer time for the vaporized part. The yields are said to be large by this manner of operation.

The non-residuum operation shown in Fig. 51 is used when the cracking is to be conducted for a maximum yield of gasoline and the formation of coke. The cycle-time-efficiency of such an operation is poor but oc-

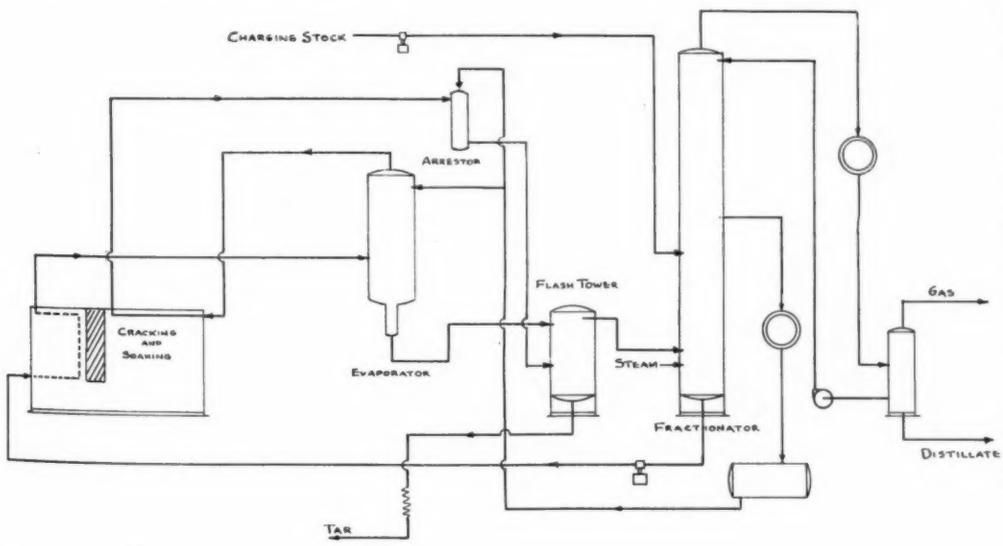
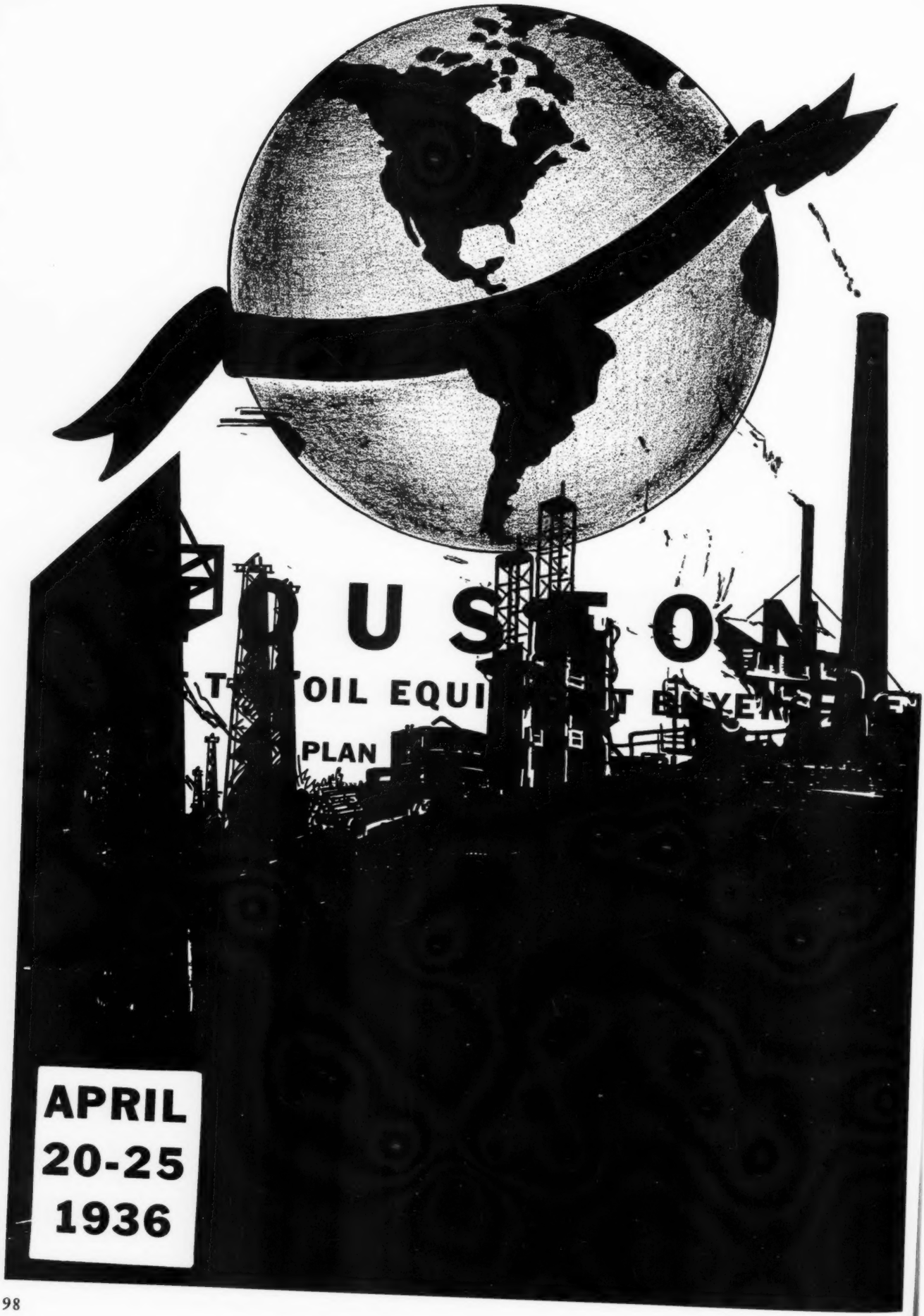


Fig. 54. Gyro vapor-phase cracking process. (Courtesy of Alco Products Company)


U S T O N
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APRIL
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casionally market conditions are such that coking is advisable.

The Dubbs Process is one of the few processes that can crack a black charging stock in the tubes of a pipestill. For this reason the yields are said to be a little higher than by most processes.

GASOLINE PRODUCTS COMPANY PROCESSES. The Combination Process shown in Fig. 52 is a complete system for distilling crude oil, cracking all of the reduced crude oil, reforming the straight-run gasoline, viscosity-breaking the fuel oil to make it more fluid, and stabilization of the total gasoline. Note that only distilled stocks are exposed to cracking conditions, but the fuel oil is heated to a mild cracking condition in the viscosity-breaking operation. Viscosity-breaking of the fuel oil aids in obtaining the high yield that is claimed for processes that crack black charging stocks.

The Deflorez Coking Process shown in Fig. 53, also discloses most of the advantageous features that were mentioned earlier in this article. Note that the coke drums are not heated externally. All the heat that they receive is provided by means of the recirculating stream of distilled gas oil and recycle stock that accumulates in the base of the second fractionator. In many respects the operation is similar to the operation of the Tubestill Process. All the most successful semi-continuous coking processes employ principles similar to those shown in Fig. 53.

GYRO PROCESS. A diagram of the process is shown in Fig. 54. The main feature of the process is the production of a clean dry vapor-phase. The gasoline is highly anti-knock and is prized as a blending fluid, but this advantage is balanced to some extent by the large gas loss; however, if the gasoline in the cracked gas is recovered by absorption, the gas loss is decreased to such an extent that the process can successfully compete with the mixed-phase processes that have been discussed previously. The unsaturated nature of the gasoline makes it hard to treat but special clay-treating methods have been developed, and inhibitors to prevent gum formation have proven useful.

QUESTIONS

1. List the four novel features of operation that are employed in most successful cracking plants?
2. What are the advantages of using a high recycle ratio?
3. Define "recycle ratio" and "crack-per-pass".
4. If the recycle ratio is four to one, and the ultimate yield of gasoline is 75 percent, what is the crack-per-pass?
   Ans. 15 percent.
5. How is it possible to crack a mixed-phase, when a homogeneous phase condition is necessary to prevent the formation of coke?
6. How does coking differ from cracking?

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Waste Eliminated in Oil Refining Plants

Waste has been eliminated to such an extent in the operation of petroleum refineries employing modern equipment that the volume of refined products is within a fraction of one per cent of the volume of crude oil run to refinery stills!

This progress is revealed in a survey of the petroleum industry's accomplishments made by American Petroleum Institute committees. They reported that efficient refining reduces the amount of crude oil required to supply a given volume of refined products, and therefore contributes substantially to conservation of the nation's petroleum reserves.

Development of the "cracking" process for producing gasoline was cited as one outstanding accomplishment in the refining field. Heat and pressure are applied to the larger molecules comprising the heavier portions, or fractions, of crude oil, virtually "cracking" them into the smaller molecules that make up the lighter fractions, such as gasoline.

As recently as 1914 only one-sixth of a 42-gal. bbl. of crude oil could be converted into gasoline, the report said. By 1926, largely because of the development of "cracking" plants, 35 percent of the crude could be transformed into motor fuel. Today a weighted average of 44 percent can be changed to gasoline, and some plants are capable of obtaining 70 to 75 percent.

"Cracking alone has produced since 1920 an amount of gasoline that without cracking would have required 6,600,000,000 bbls. of crude," the report explains. "That is an amount equal to 75 percent of all crude produced in the last ten years."

The report estimates that the industry spends more than $10,000,000,000 yearly for research and experimental work designed to improve the quality and to increase the yield of products refined from crude oil. "Cracking" plants involve the expenditure of millions of dollars for construction alone, yet the most modern refinery, unless almost constantly improved, becomes obsolete within five years.

Kellogg Reorganizes

The Kellogg Compressor and Manufacturing Corporation has been incorporated under the laws of the State of New York to take over all the assets of the Kellogg Manufacturing Company, it is announced. The latter firm has been going through reorganization for the past six months.

J. F. Weller, has been named as president of the newly-organized company. He was active in the management of the old company during its active rise but has not had his official capacity for two or three years. Associated with him in the new organization will be such old associates as John J. Sharp, H. Ozgood Holland, George B. Collins, Nicholas Arnold, and Dan Bohannon. The old representatives in the field, O. Arthur Clark, Tracy Outhouse, Niblo, Hamilton, and Lee Tuttle, as well as the entire organization, will start the new company off with a big drive, it is stated.

Simultaneously with the announcement of the formation of a new company was presented for the first time a new line of air compressors. One of the principal innovations is that the compressor is completely encased in a gun metal covering, trimmed with chromium. This gives it a modernistic appearance, and provides an element of safety, as it is impossible to have one's hands or clothing caught in the belt or other moving parts. Ventilation is provided through scientifically designed openings.

Struthers-Wells Move New York Office

Struthers-Wells Company announces the removal of their New York office to the R. C. A. Building, 30 Rockefeller Plaza, New York City. The new quarters were occupied beginning November 18th.

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

A kindly old lady visiting relatives in New York threw a nickel towards the blind man's cup. The coin missed and rolled along the pavement but the man with the dark glasses recovered it quickly.

"But I thought you were blind?"

"No, I am not the regular blind man, madame," he said, "I'm just taking his place while he's at the movies."

* * *

An Aberdonian went to a Glasgow football game. On his return a friend asked: "And did they hae a big gate?"

"Big gate, did ye say? It was easily the biggest gate I ever climbed over."

* * *

Mistress: "So your married life was very unhappy? What was the trouble? December wedded to May?"

Maid: "Lan' sake, no, mam! It was Labor Day wedded to the day of rest!"

* * *

"Now, girls," said the restaurant manager, "I want you all to look your best today. Add a little dab of powder to your cheeks and take a bit more care with your hair."

"Something special on?" asked the head waitress.

"No," informed the manager. "The beef's tough."

* * *

Three shop girls were enjoying a selection by the orchestra.

"Isn't it divine! Wonder what they're playing?" said Madge.

"It's the sextette from 'Lucia,' " announced Tillie positively.

"No, it's 'Tales from Hoffman,' " persisted Annabelle.

"I think that you are both wrong; but there's a card up there—I'll go and see for myself!" announced Madge, suiting the action to the word. She came back triumphant.

"You're way off, girls! It's the 'Refrain from Spitting.' "

* * *

Former: "Say old man, can you let me have five . . . "

Latter: "No . . . "

Former: " . . . minutes of your time?"

Latter: " . . . trouble at all, old scout."

* * *

"You poor fellow. Haven't you a home and a wife to go to?"

"Sure, but I have to wait till her husband leaves town."

Smith: "Why, old man, I thought you were dead."

Jones: "What led you to think I had passed away?"

Smith: "I overheard some people on the street speaking well of you."

* * *

Prof. Kirtland: "Before we begin the examinations, are there any questions?"

Frosh: "What's the name of this course?"

* * *

Heavy Loss

"Poor Sandy MacPherson lost a quarter of the million dollars he inherited last year."

"Is he frantic?"

"Yes, now he only has $999,999.75!"

* * *

Head Cook: "Didn't I tell you to notice when the soup boiled over?"

Assistant: "I did. It was half past ten."

* * *

Sergeant: "Did you shave this morning, Jones?"

Recruit: "Yes, sergeant."

Sergeant: "Well, next time stand a bit closer to the razor."

* * *

Hayfoot: "Hey, your shoes are mixed; you've got the left shoe on the right foot."

Strawfoot: "And here for twenty years I thought I was clubfooted."

* * *

Tough Guy: "Rat, you are about the greenest thing I have ever seen. Why, look at the hay seeds on your coat."

Meek Rat: "Them ain't hay seed, wise guy; them's wild oats."

* * *

During history class the teacher asked: "What happened in 1483?"

"Luther was born," answered a student promptly.

"Correct! What happened in 1487?"

After a long pause: "Luther was four years old."

* * *

Guilty

Accused Officer: I admit that I wuz drunk and insulting people; but I wuz off duty and in citizen's clothes, sir.

Police Commissioner: That is just the point, sir. When you are off duty and in citizen's clothes you have no more right getting drunk and insulting people than anybody else, sir.

Self-Denying Father: "Son, can't you cut down on your college expenses? You know they are almost ruining the family."

Self-Indulgent Son: "Well, I might possibly do without any books."

* * *

Country Gentleman: "Here, hold my horse a minute, will you?"

Senator from Kentucky: "Sir, I am a member of Congress."

C. G.: "That's all right. I'll trust you."

* * *

Doc: There's no need to worry about your wife. You'll have a different woman when she gets back from the hospital.

Anxious Hubby: And what if she finds it out?—*Texas Battalion.*

* * *

The family was seated at the table with a guest, who was a business acquaintance of Dad's, all ready to enjoy the meal, when the five-year-old son blurted out: "Why mother, this is roast beef!"

"Yes," answered the mother. "What of it?"

"Well, Pop said this morning that he was going to bring a big fish home for dinner tonight."

—*Detroit Free Press.*

* * *

The boat was sinking. The captain reached the crowd of scared passengers.

"Who among you can pray?"

"I can," answered the minister.

"Then pray, mister," ordered the skipper. "The rest of you put a life preserver on; we're one short."

* * *

Kind Lady: And how would you like a nice chop?

Weary Tramp: Dat all depends, lady —is it lamb, pork or wood?

* * *

See or Sea

The wife of a man who had enlisted in the navy handed the pastor of a church the following note:

"Peter Bowers having gone to sea, his wife desires the prayers of the congregation for his safety."

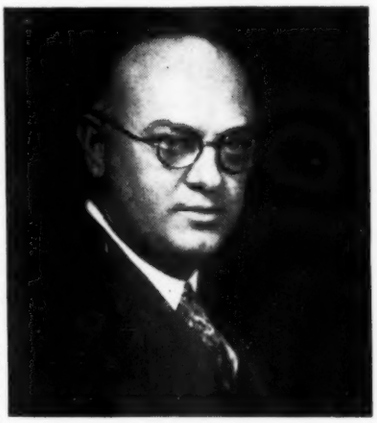
The minister glanced over it hurriedly and announced:

"Peter Bowers, having gone to see his wife, desires the prayers of the congregation for his safety."

—*Lufkin Line.*

Charles F. Roeser Heads I.P.A.A.

At the recent annual meeting in Dallas, Texas, of the Independent Petroleum Association of America Charles F. Roeser of Fort Worth, Texas, was chosen president of the organization by the unanimous vote of the membership, succeeding Wirt Franklin, who had previously announced he would be unable to consider reelection due to ill health.



CHAS. F. ROESER

Other executive officers were reelected as follows: executive vice-president, H. B. Fell; general counsel, Russell B. Brown, Washington, D. C.; assistant to the president, T. J. Steuart, Washington, D. C.; treasurer, N. T. Gilbert, Turman Oil Company, Tulsa, Oklahoma; and executive manager, C. E. Buchner, Tulsa.

Fred R. Shumack Is Purchasing Agent of Lane-Wells Company

Fred R. Shumack, formerly with Dabney-Johnston Oil Corporation, and previously with the National Supply Company for 20 years, has joined the staff of The Lane-Wells Company at their Los Angeles office as purchasing agent.

F. A. Taylor, former purchasing agent, has been transferred to the Lane-Wells sales department.

General Electric Names Two to Fill Board Vacancies

At a recent meeting of the General Electric Company's board of directors, in New York City, Henry S. Morgan and Robert C. Stanley were elected members of the board to fill vacancies. Announcement also was made of the resignation of Thomas Cochran, former director, who resigned because of ill health.

Morgan, a son of John Pierpont Morgan, until recently was a partner in the firm of J. P. Morgan and Company, and is now a director and executive officer of Morgan, Stanley & Co., Inc.

Stanley has been president of the International Nickel Company since 1922. He represents various metal and petroleum interests in the United States and Canada.

Robert J. Working to Birmingham Territory For Republic Steel

Robert J. Working has been appointed district sales manager for Republic Steel Corporation in the Birmingham, Alabama, territory, succeeding Kenneth D. Mann who has resigned to become executive vice-president of Truscon Steel Company. The appointment was announced by N. J. Clarke, vice-president in charge of sales for Republic.

Formerly in the sales department of United Alloy Steel Company at Canton, Ohio, Working was placed in charge of the Cincinnati, Ohio, district office of Central Alloy Steel Corporation in 1927. Following the Republic merger in 1930 he was made assistant district sales manager in the Cincinnati territory, being named district sales manager in 1934. His appointment is effective at once.

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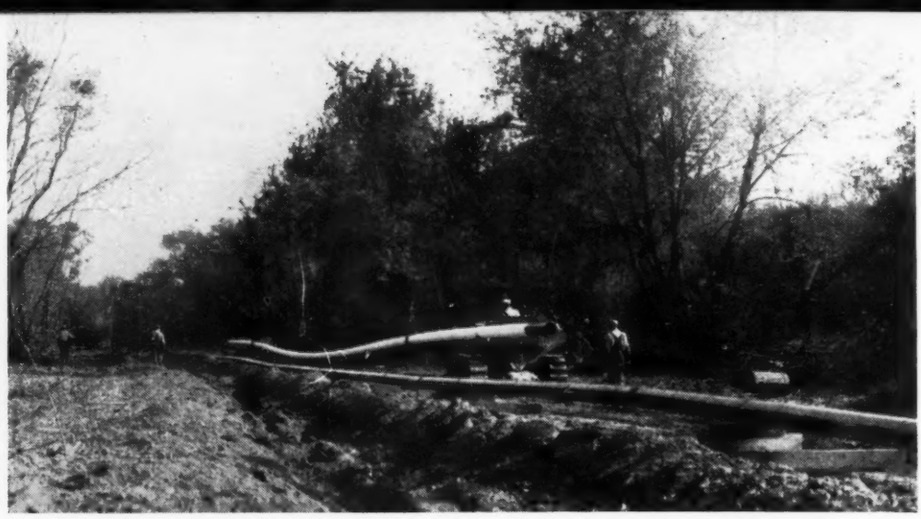

200-ft. section of pipe being moved from pipe yard to a pipe line crossing

Reconditioning and Relaying Three Approaches at Trunk Pipe-Line River Crossing

« Work carried on with practically no interruption in pumping operations »

By FRANK H. LOVE

RECENTLY the Stanolind Pipe Line Company took up, reconditioned, and relaid three approaches to the west bank of the Illinois River at Chillicothe, Illinois, thus completing a program extending intermittently over a period of four years, which has seen the river crossing itself relaid, as well as the approaches to both the east and west banks. This work was on the company's trunk line system having its northern terminus at Whiting, Indiana.

The approaches consist of three parallel lines, two being 8-in. and one 12-in., each approximately one mile in length. Only one line was taken out of service at a time, making it possible to continue pumping through the two remaining lines uninterruptedly, although on a restricted basis. So thoroughly was every step of the procedure planned and carried out that each line was withdrawn from active pumping operation but six days.

Clearing the right-of-way proved to be one of the most difficult tasks, inasmuch as the lines are laid in bottomland that is completely covered by water approximately three months of the year, this wet condition being highly conducive to the growth of willows. The thick growth had to be cut out before it was possible for the ditching machines to uncover the pipe. With these phases of the work completed, however, the oil was removed from the line to be reconditioned and placed in one of the parallel lines. This was accomplished by tapping into the lines by the method developed by the Stanolind Pipe Line Company and then pumping the crude oil from the line to be drained into one of the other lines. The method has been described previously in *The Petroleum Engineer*[1], various other publications, and by W. G. Heltzel, general superintendent of the Stanolind Pipe Line Company, in an address before the American Petroleum Institute.[2]

After the oil had been drained, water was pumped into the line to clear it of gas. When the pipe was thus made ready for removal from the ditch the collars were split on the topside by means of torches. A tractor equipped with a winch was

General view of central yard for reconditioning pipe

then hooked on and a steady pull applied until the collars were broken out. Loaded onto trucks in 20-ft. sections the pipe was transported to a central pipe yard for reconditioning. Here it was placed in racks and the collars knocked off, following which it was run through a W-K-M stationary-type cleaning machine, and classified into the proper grades. Pits more than 100 mils in depth were spot welded. No half soles or patches were used, it being considered uneconomical by the Stanolind Pipe Line Company to patch an area greater than six inches square. All ends were beveled in the yard and the pipe welded into 40-ft. joints, after which a priming coating was applied by hand.

In stringing the pipe it was unloaded directly from the trucks onto the skids where it was to be aligned for welding. This practice resulted in the pipe's surface being kept comparatively free of foreign matter and reduced further cleaning to a minimum.

Left—Removing pipe from ditch in 20-ft. joints

No sectional crew was employed in the welding of the line, the procedure being to weld completely each 40-ft. joint of pipe into the line by the bell-hole method. In this manner the pipe was made into a continuous line. Such a method has been found most economical, but is adaptable only to short lines up to eight miles in length and where the right of way is level. To carry out this plan but one crew is required, consisting of a foreman, five helpers, a tacking welder, a tractor and driver, and a sufficient number of welders with equipment to weld the pipe as rapidly as tacked. Such a crew can lay approximately three-fourths of a mile of pipe per day. Both oxy-acetylene and electric welding were employed. After the line was completed a test was made with 100 lb. per sq. in. air pressure, and it is interesting that not a faulty weld was found.

Prior to being lowered-in the pipe was coated and wrapped. Two coats of Parolite, an unfilled asphalt, were first applied to a total thickness of 3/32 of an inch. While the coating was still hot asbestos felt was wrapped around the pipe, in this manner forming a bonded job. To the outside of the felt was applied a flood coat of Parolite 1/16 inch thick. The pipe was lowered into the ditch as rapidly as coated, with the exception of loops held above the ditch for slack purposes.

Sections of pipe to be exposed to the sun for any considerable length of time, such as, for example, where they were to be pulled under pipe line crossings, were whitewashed. It is known that a marked difference exists in the sun's penetration of white and black materials and whitewash thus affords a valuable protection to the pipe coating, as it decreases the flow of the coating material. An additional advantage of the practice is that any damaged spot on the coating, caused by the accidental scraping of the ripe against a hard object, is readily detected without the necessity of minutely inspecting the pipe's surface before placing it in the ground.

One of the accompanying illustrations shows a 200-ft. section of coated pipe being moved from the cleaning yard to a pipe-line crossing. In making a crossing of this kind the pipe was welded into the length section desired, coated, and whitewashed. When needed it was transported to the job, pushed beneath the crossing pipes, and tied into the line at each end.

The pipe involved in the project had been in the ground a considerable period, having been laid variously between 1917 and 1922. In places the pipe was badly corroded and required extensive spot welding, some of the pitted pipe had a residual thickness of only 25 or 30 mils. The line taken up was of lap-weld, screw-end pipe, and originally was given but a single coating of asphalt. The soil through which it passed was partially of a sandy, caving nature, and partially of spongy texture. The latter type soil, following even a light rain, becomes virtually impassable; however, the Stanolind construction crew was fortunate in having almost ideal weather throughout the time the project was under way, accounting, in part, for the exceptionally good time of but four weeks required for completing the job.

Right—12-in. line laid ready for coating

REFERENCES

1"New Engineering Ideas Incorporated in Station Improvements," Frank H. Love—*The Petroleum Engineer*, May, 1934.

2"Advancements in Maintenance and Repair of Pipe Lines," W. G. Heltzel, before A.P.I., Chicago, October 26, 1933.

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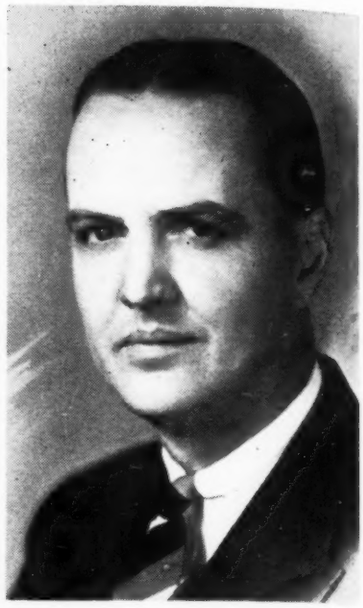
J. H. Wood, Jr., Named Vice-President and General Manager Atlantic Pipe Line Co.

J. H. Wood, Jr., Dallas, has been named vice-president and general manager of the Atlantic Pipe Line Company to succeed R. W. Howe, who died recently from injuries sustained in an automobile accident. Wood has been general superintendent of the company. He became connected with the organization 19 years ago at Philadelphia as an employe of the Atlantic Refining Company. Thirteen years ago last May he was transferred to Shreveport, Louisiana, and eight years ago moved to Dallas.



J. H. WOOD, JR.

No announcement has been made of Wood's successor as general superintendent.

C. A. Cherry Placed in Charge Buffalo Territory by Republic Steel

C. A. Cherry has been appointed district sales manager for Republic Steel Corporation in the Buffalo, New York, territory, according to an announcement by N. J. Clarke, vice-president in charge of sales for Republic. Cherry replaces Thomas B. Davies who has been transferred to Republic's Alloy Steel Division in Massillon, Ohio, as special representative.

After Mr. Cherry's graduation from the Johnstown, Pennsylvania, High School, he became connected with the Cambria Steel Company, in the Wire Sales Division. In 1917 when his firm merged to form the Midvale-Cambria Steel Company, he was attached to the Philadelphia office of the new organization. In 1918 he became private secretary to W. H. Donner, head of the Donner Steel Company. Shortly afterwards he was made assistant vice-president in charge of sales of the Donner Steel Company. In 1930 when the Donner Steel Company became a part of Republic Steel Corporation, he came to Republic as assistant manager of sales, Carbon Bar Division, which position he held until his transfer to Buffalo.

L. C. Klein Moves Office

L. C. (Lew) Klein, New York export agent for a number of manufacturers of oil field equipment, announces the removal of his office from 285 Madison Avenue, to Room 4318 at 30 Rockefeller Plaza, New York City.

W-K-M Gets New Account

W-K-M Company, Houston, Texas, has been appointed exclusive distributor in domestic and foreign fields for Lacy Turbolite, Turbo Generator, and Bug Fan, selling through all supply stores.

Special Railroad Rates Will Be in Effect for Petroleum Exposition

Special freight and passenger rates will be arranged for exhibitors and visitors to the ninth International Petroleum Exposition here May 16 to 23, 1936, by the transportation committee under A. F. Winn, traffic manager of the Skelly Oil Company, announces W. B. Way, general manager of the exposition. Winn has been re-appointed chairman of the committee and will call a meeting of railroad and other transportation representatives sometime in January.

Way also has announced that the American Petroleum Industries Committee of the A.P.I. will have two exhibits at the exposition designed to sell the oil industry on the campaign to reduce taxes on the industry.

Baird H. Markham, director of the American Petroleum Industries Committee, stopped in Tulsa en route to New York from the A.P.I. Convention and made the necessary arrangements. "Our hardest job is to sell our own industry on the campaign," said Markham.

The exposition will again honor the pioneers of the petroleum industry and select through its old timers committee the grand old man of the industry to whom a medal will be awarded. This has been done each year since 1927 and pioneers honored have been: 1927, J. Alex Stephenson, Tulsa, Oklahoma; 1928, James Amm, New York, New York; 1929, John C. Looker, Bradford, Pennsylvania; 1930, E. H. Sloan, Pittsburgh, Pennsylvania; 1934, N. V. V. Franchot, New York, New York.

Way asks that anyone having some old timer and pioneer to nominate for the position to send in his name to exposition headquarters in Tulsa.

With approximately 90 percent of the exhibit space sold efforts are now being concentrated on obtaining the largest attendance in the exposition's history, says W. G. Skelly, president.

"A larger show than was held either in 1930 or 1934 is already definitely assured, as the major supply houses, manufacturing concerns, and scientific and technical firms have purchased more space than in previous years and state that they have more improvements to show than formerly," said Skelly.

"Oil men in foreign countries are being urged to attend the exposition and then go to Dallas for the Texas Centennial," says W. B. Way. "We expect that representatives from foreign nations will outnumber those attending any previous show. In 1934, 18 nations were represented."

Champion Returns to BJ Headquarters

Frank Champion, general sales manager for the Oil Tool Division of Byron Jackson Company, has returned to Los Angeles after a ten weeks' trip that took him throughout the Mid-Continent and to New York.

Sales are on the increase, according to Mr. Champion, and the trend towards modernizing operations indicates a good year ahead for BJ drilling and production tools.

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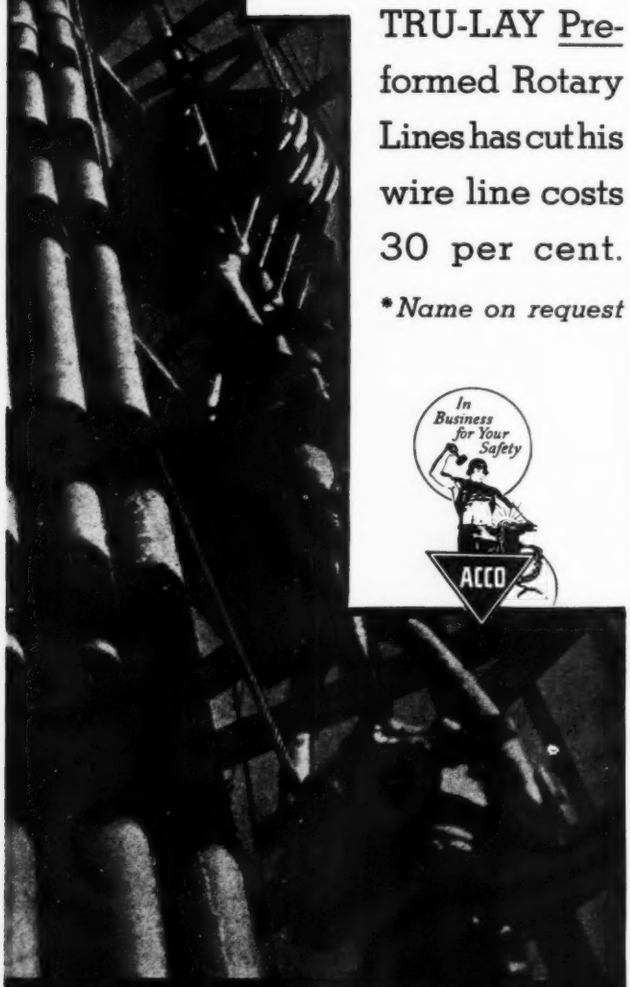

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INDEX *to* ADVERTISERS

American Cable Co. 114
American Hammered Piston Ring Co.
American Iron & Machine Works Co.
American Meter Co. 14
American Sheet & Tin Plate Co. 2
American Steel and Wire Co.
Anderson, Alexander, Inc.
Armstrong Bros. Tool Co. 113
Axelson Manufacturing Co., Ltd. 109
Baash-Ross Tool Co.
Baker Oil Tools, Inc. 101
Baroid Sales Co. 83
Bradford Motor Works 112
Bridgeport Machine Company, The 95
Broderick & Bascom Rope Co.
Byron Jackson Co. 79
Cavins Co., The 71
Chaplin-Fulton Mfg. Co., The 112
Chapman Valve Manufacturing Co., The
Climax Molybdenum Co.
Continental Supply Co., The 61
Cook, C. Lee, Mfg. Co. 67
Cooper-Bessemer Corporation, The 43
D. & B. Pump & Supply Company
Dresser, S. R., Manufacturing Co. 55
Eagle-Picher Lead Co., The
Eastman Oil Well Survey Co. of Texas 107
Edwards, E. H. Company 19
Elliott Core Drilling Co. 52
Emsco Derrick & Equipment Co. 69
Ensign Carburetor Co.
Ethyl Gasoline Corporation
Falk Corporation
Fluid Packed Pump Co. 70
Frick Reid Supply Corp. 3
Gaso Pump & Burner Manufacturing Co.
General Electric Co. 11
Globe Oil Tools Company
Gott, H. P., Manufacturing Co. 113
Guiberson Corporation
Halliburton Oil Well Cementing Co.
Hazard Wire Rope Co. 105
Hughes Tool Co. Back Cover
Hyatt Roller Bearing Co. 12
Hydrauger Corporation, Ltd. 113
Hydril Company 77
Industrial Brownhoist Corp.
International Derrick & Equipment Co.
International Harvester Company of America 5
International Petroleum Exposition
Jones & Laughlin Steel Corporation 8
Kerotest Manufacturing Co. 4
Kobe, Inc. 63
Lane-Wells Co.
Leschen, A. & Sons Rope Co. 16
Linde Air Products Co. 91
Lufkin Foundry & Machine Co. 47
Lufkin Rule Co. 113
MacClatchie Mfg. Co. 74
Martin-Decker Corporation
Mason-Neilan Regulator Co. 6
Mepham, Geo. S., & Co. 1
Merco-Nordstrom Valve Co. Front Cover
Metric Metal Works 14
Mission Mfg. Co.
Moore, Lee C., & Co. 45
National Supply Companies, The 10
National Tube Co.
National Tube Co. (Stainless)
O. C. S. Mfg. Co., The
Oil Center Tool Co. 65
Oil Equipment and Engineering Exposition 98
Oil Well Supply Co. 21
Oxweld Acetylene Co. 91
Parkersburg Rig & Reel Co. 103
Patterson-Ballagh Corporation 7
Petroleum Electric Power Club 9
Petroleum Rectifying Co. Inside Back Cover
Pittsburgh Equitable Meter Co. Front Cover
Prest-O-Lite Company, Inc., The 91
Reed Roller Bit Co. 26
Republic Steel Corporation 57-58
Shaffer Tool Works 87
Smith, A. O., Corp. 48-49
Smith, E. M., Co. 108
South Chester Tube Co.
Sperry-Sun Well Surveying Co. 113
Titusville Iron Works Co., The
Tretolite Company Inside Front Cover
Trimont Manufacturing Co.
Union Carbide & Carbon Corporation 91
Union Carbide Sales Co. 91
United States Rubber Co.
Union Wire Rope Corporation
U. S. Steel Corporation Subsidiaries 21
Vernon Tool Co., Ltd. 106
Waukesha Motor Co.
Wickwire Spencer Steel Co.
W-K-M Company, Inc.
Youngstown Sheet & Tube Co. 13